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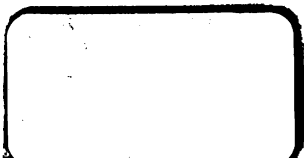
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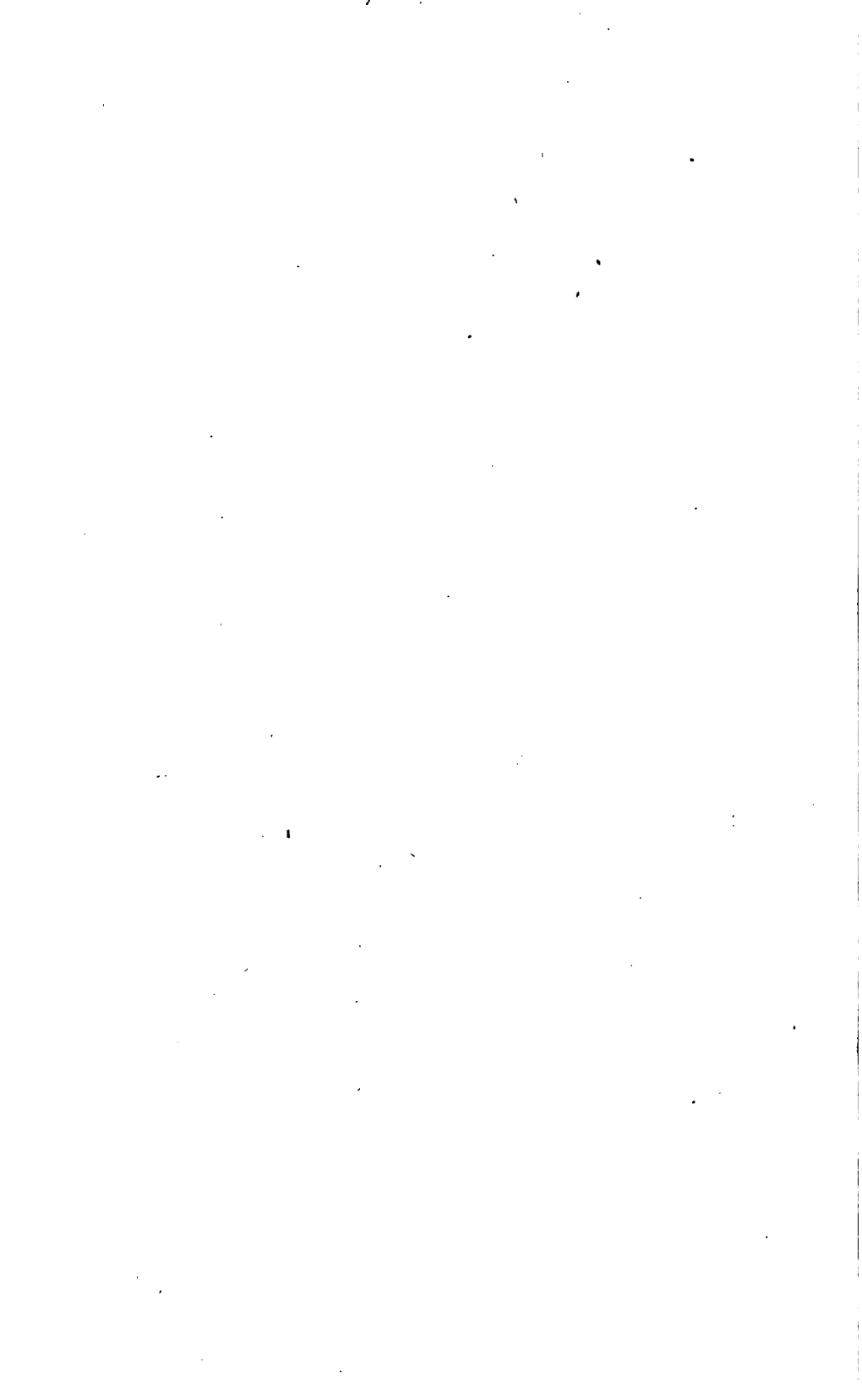
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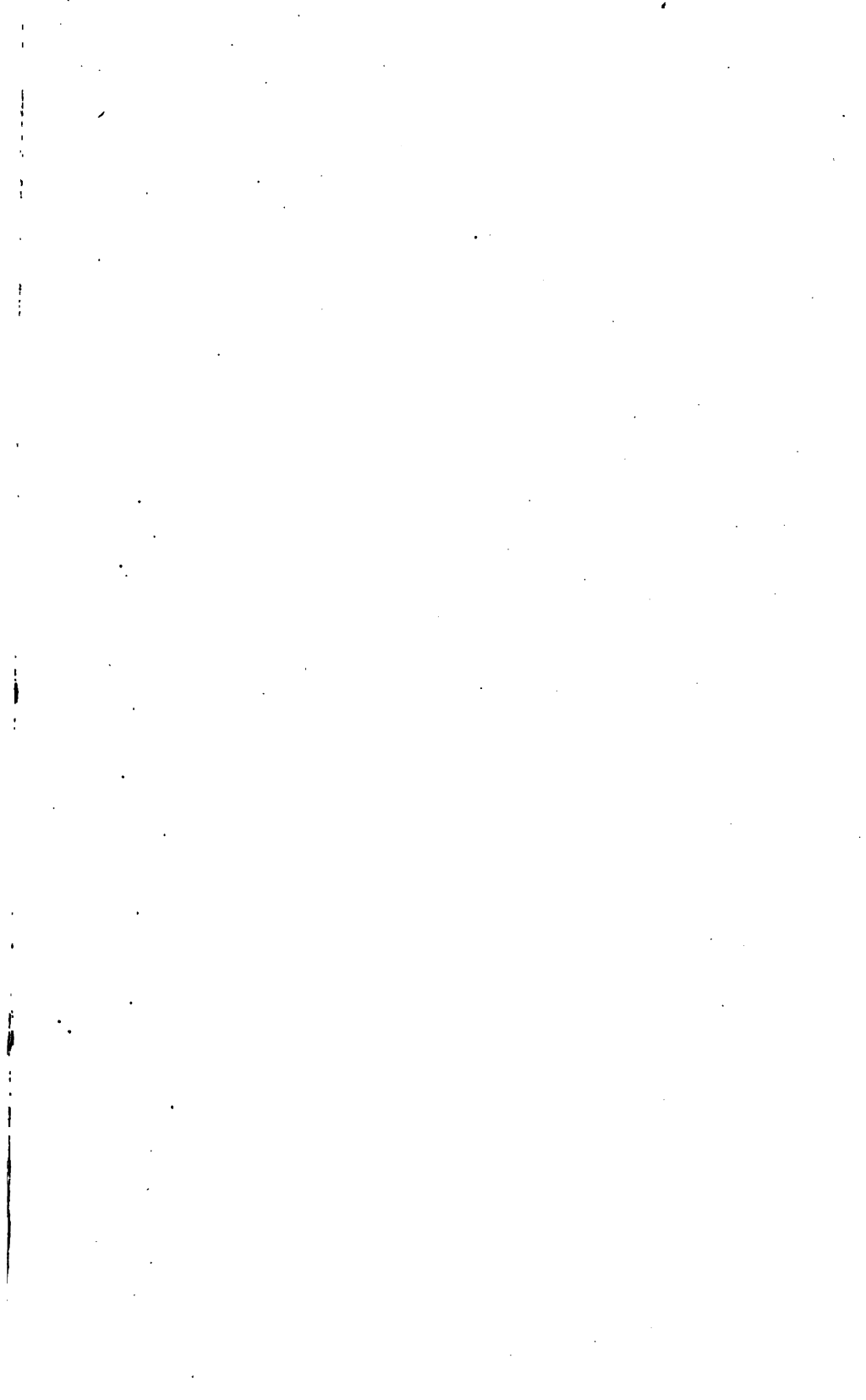


Plate no. 15

GEOLOGICAL SURVEY

—OF—

ALABAMA.

EUGENE ALLEN SMITH, PH. D., STATE GEOLOGIST.

REPORT

ON THE

GEOLOGICAL STRUCTURE OF MURPHREE'S VALLEY,

—AND—

ITS MINERALS AND OTHER MATERIALS OF ECONOMIC VALUE.

BY

A. M. GIBSON,

ASSISTANT GEOLOGIST.



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To His Excellency, Thomas G. Jones,

Governor of Alabama:

• SIR—I have the honor to submit herewith the Report of A. M. Gibson, Assistant Geologist, upon Murphree's Valley. From the preface it will be seen that this report was in great part written several years ago. The delay in the publication has come from several causes, chief among which was the lack of a suitable map to illustrate it. The general geological map of the state being at the time of the writing of this report in course of construction, it was thought better to use that in illustration than to duplicate a part of it for this special purpose. Every one who has had experience in such matters will readily understand how the completion of such a map as that of the state of Alabama has taken far more time than was anticipated at the outset.

The present report deals with the geological formations of the valley alone; other reports of Mr. Gibson have been published, treating of special areas of the Coal Measures adjacent to this valley, and one is now in course of preparation describing in detail the Coal Measures of Blount Mountain lying to the east of Murphree's Valley.

Very respectfully,

EUGENE A. SMITH,
State Geologist.

University of Alabama, Dec. 27, 1892.

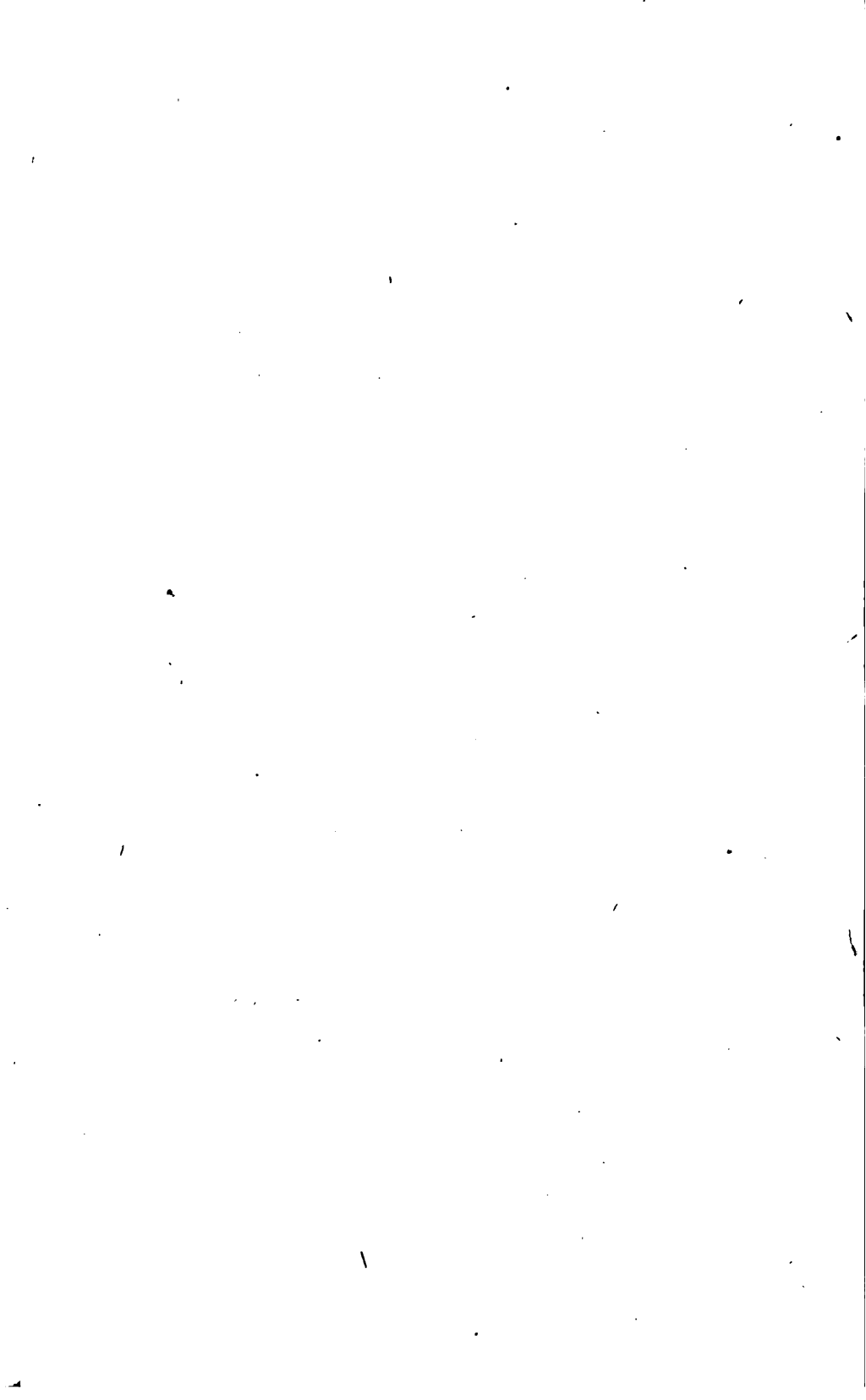


TABLE OF CONTENTS.

PREFACE	5
Location and Area of the Valley	7
Drainage	8
Topography	10
Sand Valley	12
The Central Valley	12
The Eastern Valley	13
Straight Mountain	13
Red Mountain	14
Sand Mountain	15
Geological Formations	17
Carboniferous	17
Coal Measures	17
Sub-Carboniferous	20
a. Mountain or Bangor Limestone	20
b. Oxmoor or Lagrange Sandstone	22
c. Fort Payne Chert, Siliceous Group ...	23
Devonian	24
Black Shale	24
Silurian	25
1. Clinton or Red Mountain	25
2. Trenton and Chazy, Pelham Limestone	25
3. Knox Dolomite	25
Cambrian	26
Sparry Limestone or Coosa Shale	26
Structure	28
The Great Anticlinal Fold	28
Transverse Folds	34
Other Peculiarities of Structure	36
Absence of Certain Formations on S. E. side of Valley	36
Comparison of ends of the Valley with Central parts	37
Horse-shoe curve of upper end of Valley	38
End of the Fold	38
Economic Geology	39
Hematites of the Red Mountain or Clinton Formation	39
Details of Occurrence of Red Ores	41
On Northwestern side of Valley	41
On Southeastern side	69
Estimates	87
Brown Iron Ores—Limonites	89
The First or Lowest Limonite Horizon	90

The Second Limonite Horizon	91
The Third Limonite Horizon	92
The Fourth Limonite Horizon	92
The Fifth Limonite Horizon	92
The Sixth Limonite Horizon	93
Details	94
Champion Mines	95
Estimates of the Quantity of Limonite in Murphree's Valley	108
Manganese Ores	110
Geological Position	112
Details of Occurrence	112
Industrial Materials	120
Brick Clay	120
Halloysite or Pholernite	121
Hone Stone	122
Building Stone	122
Fire-Proof Rock	124
Conclusion	126

PREFACE.

In the following Report that part of the great Jones Valley, or Birmingham fold, lying in the counties of Blount and Etowah, is specially presented.

The geological reconnaissance on which it is based was made several years ago, when the mineral contents of the region were wholly undeveloped. Average, or fairly representative samples of all the ore beds, or in most of the mineral area, could not then be obtained. To avoid the appearance of giving undue prominence to certain places, and too little to others, of favoritism or partiality, it was deemed fairer to all sections and parties to make no analyses of special samples, but to subject all alike to the same judgment of quality, and approximate per centage of metal.

Since the text was written iron ore mines, and limestone quarries have been extensively worked near Village Springs, the Compton Mines; and brown ore, near the middle of the valley, the Champion Mines; building rock quarried near Oneonta, and red ore mined at DuBois Station; in each of these places the estimate of quantity and quality of the ore, as given in this report, has been fully realized, and more than realized in the quality of the limestone and building rock. It is, therefore, with increased confidence in its general correctness that this brief sketch is submitted to the public.

Chepultepec, Ala., June, 1890.

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MURPHREE'S VALLEY.

LOCATION AND AREA.

This valley is the north-eastern prolongation of Jones' Valley. It bears the name Murphree's Valley (from its earliest white settlers) through Blount county, and up to where the Locust Fork of the Warrior crosses it, in Etowah county. From the Warrior to its upper end it is called Bristow's Cove. The term "cove," however, is not properly applied here. It is not a cove, such as is usually designated by that name, but a portion, the upper end, about twelve miles in length, of this long, narrow valley. It presents throughout its whole length the same geological and topographical features, and must, therefore, be considered accordingly, without reference to local names or subdivisions.

The entire length of this fork of Jones Valley from the county line between Blount and Jefferson, at Village Springs, to its upper end, is about 32 miles, on a direct line. Its usual breadth is from three to five miles. Its narrowest portion is near its junction with Jones Valley; thence north-eastwardly it gradually widens, and in ten or twelve miles it has reached its maximum width, which it generally preserves till its abrupt termination in the Raccoon Mountain.

Its trend or course is nearly, but not quite, identical with the axis of Jones' Valley. The latter bifurcates* at the south-

*Mr. Gibson uses the name Jones' Valley to designate the entire valley area separating the Cahaba and Warrior Coal Fields below Village Springs. This area, however, is in its structure a double anticlinal fold with synclinal ridge between them. Both the folds have been overlapped towards the northwest, and each has a fault close to its western border and approximately parallel thereto. Erosion has formed a valley out of each of the

western end of Raccoon or Blount Mountain, as it is here called; one branch deflecting eastward joins the Cahaba Valley, the other a little westward of the course of its former axis, makes Murphree's Valley. Just as a stream divides around an island, has the axis of Jones Valley here divided and deflected to the right and left around the point of the mountain.

The trend of the axis of the Murphree's Valley fold for a few miles above the bifurcation is N. N. E. From the Blackburn Fork of the Little Warrior to the Calvert Fork, it is due N. E. From the Calvert Fork to the upper end it gradually becomes more and more E. N. E., deviating, however, in its whole length only two miles from a due N. E. and S. W. line.

DRAINAGE.

To an observer it seems a singular fact that all the principal streams of this valley flow across it; that they flow out of the valley and on to the mountain, as the COAL MEASURES are generally called. This fact is easily explained. This valley is emphatically a *valley of elevation*. And though it has been scooped out by water, and denuded down to the

anticlinals—Jones' Valley on the east, Opossum Valley on the west,—while the synclinal between them, in the vicinity of Birmingham, appears in the Chert ridge of the North Highlands. Murphree's Valley is, therefore, the extension northeastward of the westernmost of the two sub-valleys named, i. e., Opossum Valley, while Jones' Valley proper passes towards the northeast into the Great Coosa Valley about Springville.

From the latitude of Village Springs, northeastward the synclinal separating these two folds, is considerably wider than is the case near Birmingham, and includes strata as high up in the geological series, as the Coal Measures. As far south as this synclinal has Coal Measures for its surface rocks, it is known as the Blount Mountain, ending near Village Springs. Below this, towards the southwest where the surface rocks are chiefly the cherts of the Knox Dolomite, with occasional traces of overlying strata up to Clinton, the synclinal so far as I know has no distinctive name beyond the general one of Flint Ridge, till in the vicinity of Birmingham, it has recently been called the North Highlands. See map section in appendix to Squire's Report on Cahaba Coal Field.

E. A. S.

lower Silurian and Cambrian formations, yet its floor is from *one to two hundred feet higher* than the synclinal trough in the COAL MEASURES, near its N. W. side, in which the Warrior rivers flow. Another fact must also be noticed in this connection. This valley has no synclinal depression *belonging to its fold* on the S. E. side. That side is much higher than the floor of the valley, and slopes toward it; hence the streams which rise on that side run into, and across the valley, and out through its north-western rim into the low lying synclinal trough, between this and the Sequatchie fold. A profile view would present this as a great valley scooped out along the side of a long north-west slope; one of nature's immense, but now disused, hillside ditches, which once perhaps answered the purpose of drainage, but now offers no impediment to the streams flowing across it from the Raccoon Mountain. The breadth of this slope is from 15 to 20 miles. Its highest part is the eastern top of the Blount Mountain, or western rim of the great Cahaba and Coosa folds. The average declination throughout this distance is about 25 feet to the mile. The fall of streams before they reach the valley, and after they leave it, is very great, affording many fine mill-seats and ample water power for industrial machinery.

The only exception to the course of the drainage across the valley is in that part lying north-east of the Locust Fork of the Warrior, known as Bristow's Cove, in which the streams rising in the valley flow down it about 10 or 12 miles to the Warrior River. In this upper part of the valley, and in the long mountain north-east of it, extending along the north-western side of Wills' Valley, the slope of the country seems to be to the south-west, as the streams all flow in that direction, along the margin of Wills' Valley, thence gradually changing into a north-western course to the Tennessee river.

TOPOGRAPHY.

The topographic features of Murphree's Valley are in large measure determined by the quality and altitude of the strata out of which the valley has been excavated. It may, therefore, be well to introduce here a table showing the order of succession of the geological formations concerned in the structure of this part of the state, together with the thickness of the several divisions, and the lithological characters of the principal strata of each.

Under appropriate heads below will follow further details concerning these formations.

TABLE OF THE PALEOZOIC FORMATIONS OF ALABAMA,

Which take part in the structure of Murphree's Valley, with the thickness of each in and adjacent to the Valley.

PERIOD.	FORMATION NAME.	THICKNESS.	TENNESSEE EQUIVALENT.
Carboniferous...	Coal Measures: Sandstones and conglomerates.....	100 feet and upwards ...	Coal Measures.
	Mountain Limestone (Bangor)	200-300.....	} Mountain Limestone.
	Lagrange or Oxmoor Sandstone.....	80-100.....	
	Siliceous Group or Fort Payne Chert.....	200.....	Siliceous Group.
Devonian.....	Black Shale.....	10-40.....	Black Shale.
Silurian	Clinton or Red Mountain Sandstones and Shales.....	150.....	Dyestone Group.
	Trenton and Chazy: Pelham Limestone	250.....	Trenton and Nashville.
	Knox Dolomite: Cherty.....	1,200-1,500....	Knox Dolomite.
Cambrian.	Sparry Limestone: Cόosa Shale.....	1,200.....	Knox Shale.

The topographical features of this valley differ slightly, though not essentially, from those of Jones' Valley. The longitudinal ridges are more distinctly marked, and more persistent. The Red Mountain occupies a more central position, being near the middle of the valley, and the Carboniferous or Mountain Limestone is much more extensively exposed on the north-west side. The structure of the fold is different, but the formations exposed are precisely the same.

The prominent longitudinal ridges divide this valley into several sub-valleys. These are called by different names respectively, and present different features. No two of them can be distinctly seen at once from any standpoint. It is therefore necessary to examine them all consecutively to get a clear knowledge of Murphree's Valley.

Sand Valley.—The first of these sub-valleys on the north-west side is called *Sand Valley*. It has the coal measures of the Warrior Coal Field for its north-western margin. Below the coal measures, at the base of Sand Mountain, as it is called, the carboniferous or mountain limestone is largely exposed. But the most prominent rock in it is the Oxmoor or Lagrange Sandstone, the disintegration of which has given it a sandy soil, and large accumulations of sand; hence the name, "Sand Valley." The Red Mountain, with its base covered with sub-carboniferous cherts, makes its south-east margin.

This valley is often narrow, but where it is traversed, or crossed by a stream, it contains good bodies of land. Towards the upper and lower ends of this valley it has its most continuous wide belts of arable soil, and many good farms.

The Central Valley.—The Red Mountain, the most prominent and persistent ridge of this valley, separates the Sand Valley from the central or middle sub-valley. It is locally known as "Red Mountain Valley." It is of varying width, but is generally the broadest and most important of the sub-valleys. On the side next to Red Mountain it has a rich, dark red soil mainly derived from the iron ore and limestone

of the mountain, the debris of the Clinton and Trenton rocks. The other side is mainly the detritus of the Lower Silurian Cherts.

The Eastern Valley.—Broad massive ridges mostly of Lower Silurian Cherts, partly of Cambrian Limestone, separate the Red Mountain Valley from the next valley on the south-east, as far up as they are separated. This dividing ridge is very prominent from Village Springs to the Champion Mines, a distance of fifteen miles. Farther up the valley it becomes more knobby and less prominent, and entirely disappears a little above the south-western line of Etowah county. Above this, for ten miles or more, both of the sub-valleys south-east of Red Mountain are merged into one. Near the upper end of the valley, however, the division between the two sub-valleys is again established by a ridge of lower Silicious (Fort Payne) Chert, which gradually rises up a little beyond Aurora P. O., and increases in height as it curves round the upper end of the Red Mountain Valley and joins there with the curved end of Red Mountain.

The sub-valley lying on the south-east side of Murphree's Valley has no distinctive name. It might be called the Limestone valley, or the Cambrian valley, as all the exposures of the Cambrian limestone of this region are in it, and for fifteen miles above Village Springs this valley has been mainly scooped out of, and is floored with that rock; but neither of these names would properly designate its upper part. It will be properly referred to as the eastern or south-eastern sub-valley. It has generally a good soil, and contains many good farms. The south-eastern side of it is generally very broken, with ridges and knobs of Clinton and Sub-Carboniferous strata. These are very irregular in outline, and as their strata dip at high angles, they are generally steep.

Straight Mountain.—Immediately adjoining these ridges and knobs on the south-east side is a high ridge of Carboniferous rocks, all nearly to quite vertical, and 300 to 400

feet high above the floor of the valley, and from 100 to 200 feet above the general level of the Coal Measures beyond. This ridge is very narrow, the breadth of its base at the level of the valley being only 600 to 700 feet. The sides very steep, yet smooth; the top sharp backed, scarcely a rod in breadth, yet of almost uniform height. Denudation has had but little effect on it. No wind gaps, or gullies, or areas of abrasion are seen. Its symmetry is unbroken, save where the streams rising in the mountain beyond have cut their way through it into the valley below. The channels of drainage here have evidently not been changed since they were first established.

The height and volume of this vertical ridge, or wall, are nearly uniform for long distances, and it seems to be exactly parallel with the axis of the valley. This remarkable topographical structure is the south-eastern edge, or rim of Murphree's Valley, and bears the local name of *Straight Mountain*.

The vertical portion of this marginal rim gradually diminishes in prominence toward the ends of the valley. Its greatest elevation and volume being opposite that part in which the Cambrian limestone is exposed; that is from a little below Remlap, for fifteen miles north-east to a little above the Champion Mines.

Near the upper end of the valley the vertical rocks are not seen; apparently they have passed beneath the surface, and the rim or edge of the valley is the face of the Coal Measures, dipping for a short distance to the south-east, at an angle of about 60°.

Red Mountain.—This most important topographic as well as economic feature of the valley lies generally to the west of the central line of the valley, but near its head the Red Mountain is about equi-distant from the two margins of the valley. It is made up usually of three formations—the Clinton, the Black Shale and the lower member of the Sub-Carboniferous. In many places a fourth underlying formation, the Trenton, is found along the inner or valley side of the Red Mountain, extending in some cases almost or quite

to its summit. In this case the other formations named extend along the outer or western slope of the mountain. On account of the red iron ores which it contains, the Red Mountain will be described in detail below, and further mention here is unnecessary.

Sand Mountain.—The north-west side of the valley also has an elevated rim called "Sand Mountain." Often the whole of the Coal Measures lying west and north-west of this valley are also called Sand Mountain, but the only portion of this region that is much elevated, and presents a mountainous character, is the elevated rim of the valley, which, when seen from a distance, is always especially called the "Sand Mountain." This elevated rim extends the whole length of the valley, and is usually 300 to 400 feet high above the floor of the valley. Its strata are the lower portions of the Carboniferous, consisting of lower Coal Measures in its upper part, and the upper part of the Sub-Carboniferous or mountain limestone at the base. The dip of the strata here varies but little from 15° to the north-west.

While this rim has about the same elevation as the one on the south-east side, it presents very different features. On the side next the valley it is irregular in its slope, rough and rocky, with many slides and benches, deeply gullied and indented, showing throughout the wear and tear of erosion. The top is not uniform in outline or elevation. The trend only approximates the direction of the axis of the valley; this however is largely due to its great but unequal erosion on both sides. On its top, and beyond, it shows much evidence of denudation, large areas of bare rock, often lower conglomerate are exposed. Its slope north-west for two to three miles to the synclinal trough in which the Warrior river flows is gentle, and gradually diminishing.

It has been suggested as probable that the courses of the streams, and the direction of the drainage here, have been changed by the uplifting fold of the valley. In support of this view it is urged that the rising fold across the course of the streams must necessarily have deflected them into new

channels, if not into new directions. But admitting that the direction of drainage has not been materially changed, it is urged that the deep canon-like gorges, in which the streams flow through the Sand Mountain, are apparently of more recent origin than their channels on the other side of the valley. The evidence of the apparently greater age of the stream channels on the south-east side of the valley consists in their greater general breadth, and in the considerable amount of bottom lands that exists along them; while on the north-western side no bottom land exists along their narrow channels from the edge of the valley till they reach the synclinal.

These facts are apparent, and would usually be persuasive, if not conclusive of the subject. But here, with the changes of levels produced by the rising fold, they may have originated from other causes than difference in age. It has already been stated that this Sand Mountain rim has been greatly denuded. Before its elevation, the channels of the present streams (if then existing) must have been several hundred feet above their present beds. With the rising rim the ancient flood plains would be washed away, and the streams would cut down their channels deeper and deeper, as elevation progressed. Hence, on the theory that the drainage here was established before the fold began to rise, it does not necessarily follow, from the observed facts, that the course of the streams was thereby materially changed. But it might also be assumed that the rising of this fold, and the rising of this region above the waters, and the establishment of its drainage were all synchronous events, and that they proceeded and progressed *pari passu*. Upon this hypothesis the deep narrow gorges cut by the streams through Sand Mountain, would be accounted for by the greater depth they had to be excavated. While above and below, the streams were widening their flood plains; here their whole force was expended in cutting down their beds. Without endorsing either hypothesis, it is sufficient for the present purpose to present the facts as stated.

Other topographical features being closely connected with

the geological structure, will be more clearly presented in the progress of its structural description. It will be understood from what has been stated that all of the sub-valleys described, with the intervening marginal ridges, make up and constitute Murphree's Valley. That it is environed by Coal Measures, except on the south-west end; and that these measures adjoin or abut against the valley in an elevated rim on both sides.

GEOLOGICAL FORMATIONS.

On a preceding page we have given a table of the Geological Formations exposed in Murphree's Valley. It is necessary, for the proper understanding of much that follows, that we should now describe these formations in some detail. In this description they are considered in descending order:

CARBONIFEROUS.

1. *Coal Measures.*

The coal measures cover the surface on both sides of this valley. On the north-west side they are thin, rarely exceeding 100 feet at the edge. Only the base rocks have been left. The lower conglomerate is generally the crest of the valley rim. On a portion of the opposite side these measures are known to be over 2,000 feet thick. Nearly this depth of strata has therefore been washed away from the top of the north-western rim. The measures, however, rapidly deepen towards the north-west. The dip of the strata in that direction is about 15° . The lower conglomerate rock here, as elsewhere, is from 80 to 100 feet thick. In its lower part it is often strictly conglomerate, wholly composed of pebbles, firmly cemented together with silica, or silica and iron.

Generally the pebbles are small, white and well rounded. Occasionally more angular fragments, and pieces of carbonate of iron, form a breccia. In other parts the pebbles are irregularly scattered, or occur in patches and irregular streaks. A large portion of the rock is usually a stratified sandstone, and affords good building rock, which will be referred to again in its proper place.

Beneath this conglomerate occur shaly and soft rocks from twenty to fifty feet thick, resting on the Carboniferous Limestone. It is very surprising that there should be here only this insignificant amount of strata between the limestone and the conglomerate. This is the place of the sub-conglomerate coals, which in Tennessee, and many parts of Alabama, are of the first importance. Twenty miles east, along the face of the Raccoon, (or Blount Mountain, as it is there called,) and the Chandler Mountain, this stratum is from 500 to 800 feet thick. It there carries four seams of coal. Three of them perhaps unimportant; but the upper one, where cut, measured three feet eight inches thick. And yet in so short a distance, this stratum is reduced to an average of about thirty feet. As might be expected, this thin stratum holds no known workable seam of coal. At only one place, where the Blackburn Fork of the Little Warrior cuts through this rim, was any coal found in it. That was in an irregular stratum of slate, with a still more irregular seam of coal never exceeding three inches thick.

These lower Coal Measures are always characterized by irregularity in their thickness, and in the thickness of their coal seams. A short distance may, therefore, make a great difference in both, yet it is not probable that they will be found of much value on this side of the valley. Above the lower conglomerate, the higher, or intra-conglomerate, or super-conglomerate Coal Measures are found, increasing in thickness toward the synclinal axis, and corresponding with the same measures on the south-east side of the valley, which have been described in a previous report.

It may, however, be here repeated, that the 2,000 feet of coal strata, assumed to have been swept away on the north-

west side of the valley, have been protected and preserved on the south-east side. This was occasioned by the vertical break on that side, whereby the adjacent coal measures did not partake, to any great degree, in the uplift of the valley.* The valley rocks were, therefore, relatively *pushed up past the Coal Measures* to a height of much more than the *whole thickness* of the measures; though subsequently denuded down *below the level of their surface*. On the north-west side a similar break did not occur, but the fold slanted away into a regular synclinal, exposing its surface to denudation.

On the eastern side of T. 12, R. 1, east, and in T. 11, R. 2, east, there is an elevated region in which the various branches of Dry Creek have their source, that is known by the name of Berry Mountain. This elevation is only a portion of Coal Measure strata, that withstood the denudation. It contains at least *three seams* of coal, which are wanting in the surrounding region. They are of workable thickness, one of them nearly three feet, and are regarded as good shop coals. This is as far as they have been tested. As a report on these coals has already been published, (Report on the Coal Measures of the Plateau Region,) it is not deemed necessary here to enter on a further description.

The face of the Coal Measures presents the same general appearance up to the head of the valley. At the head, and near the middle of the curve, the great fault described below cuts the Coal Measures, as it has done the underlying rocks, and a sink apparently of 200 feet occurs. It may be much more, but 200 feet is all that could be verified. This is, as heretofore shown, a sinking down or throw of the strata, along the south-east side of the fault line. The Coal Measures are therefore thicker on that side than the other. The top of the mountain is the same height on both sides of

*This seems to be a natural consequence of the peculiar structure, explained below, by which the Blount Mountain synclinal is thrust or lapped *under* the Murphree's Valley Arch. The usual structure in this part of the state is the thrusting or lapping over of the arch towards the north-west, while here, by the underthrust mentioned, the fold or arch *appears* to be thrust up over towards the south-east.

it is rarely of the same quality from bottom to top at any place. Usually the members near the base of a lime formation are the best, yet to this rule there are many exceptions. Much of this formation is profusely mixed with matter of Coralline origin. This contains too much silica; and is therefore unfit for making lime, or for flux. Those coralline portions are usually in the upper half of the formation. Sometimes they are wholly wanting, and the entire ledge is good limestone. In general, these coral formations are not scattered promiscuously through the rocks, but lie mainly in horizontal belts; often beginning at a line, or terminating at a line, with pure limestone below or above. Many of the organic remains in this rock are of indistinguishable form, probably sponge-like or gelatinous bodies, whose substance has been replaced by silica. Many, however, are beautiful and well defined corals; among them were formed *chain coral*, *Lithostrotion Canadenses*, *Lithostrotion basaltiforme*, *Cyathophyllum*, &c. Great numbers of *Enerinites* and some characteristic mollusks, *Productus*, *Spirifers* and *Terebratula* being prominent.

b. Oxmoor Sandstone (Lagrange Sandstone).—The next formation below* the Carboniferous limestone is known, in this State at least, by the name of the Lagrange or Oxmoor Sandstone. It consists of a heavy ledge of sand rock, from 80 to 100 feet thick. It is prominent all along the Sand Valley, forming generally a ridge of soft sandstone, sometimes rising into bold mural bluffs the whole thickness of the rock. It is also very prominent at many places on the south-east side, sometimes forming prominent ridges, though nowhere presenting mural faces and bluffs, as it does on the north-west side. The rock is properly a freestone, easily crumbled into sand. The great quantity of it that has dis-

*The Oxmoor Sandstone is one of the members of the Mountain Limestone group, and in many places has the limestone both *above* and *below* it. The Mountain Limestone, as a group, appears to be the equivalent of the Chester group of the Western geologists.



integrated has formed immense beds of sand, and (on the north-west side of the Main valley,) covered the little valley at its base with sandy soil. No fossils were found in this rock. It seems to have been so rapidly formed as to preclude marine life; and yet the types of life, so abundant in the rocks beneath it, again present themselves in the limestone above it, as though there had been no break in their existence. This is the more remarkable, because this plate of rock is of great extent, being apparent in all the valleys of North and North-East Alabama.

c. Fort Payne Chert (Siliceous group).—Beneath the Oxmoor or Lagrange sandstone, in Murphree's Valley, is a thick bed of cherty rocks of Sub-Carboniferous age, to which we have given the above name.*

These are, by estimate, usually about 200 feet thick, and terminate at the Black Shale.

These siliceous rocks of the Subcarboniferous are well exposed on the north-west side, and generally can be easily traced on the south-east side. They are usually so full of fossil forms and fragments as to be readily identified wherever seen. At two places on the south-east side of the valley were found large deposits of limestone lying at the base of this formation. This limestone is not common in Alabama, except in the Tennessee Valley, though it has been seen at

*This group, which as a whole, seems to correspond with the St. Louis, Keokuk and Burlington beds of the Western geologists, is made up in Alabama of limestones of varying degrees of purity. When the limestone is highly siliceous, as is usually the case in this state, the calcareous matter has been thoroughly washed out, in exposed outcrops, and the siliceous matter remains mostly in fragments full of cavities, caused by the dissolving out of the stems of encrinites and of other fossils. In the valley of the Tennessee it is usually not difficult to distinguish between the St. Louis division and those underlying it; but in the anticlinal valleys further south, where this part of the Subcarboniferous formation is represented, as a rule, by loose cherty fragments, the distinction is not so clear, and we have, therefore, been accustomed to use one term to designate the whole siliceous series below the Oxmoor sandstone, and we call it Fort Payne Chert.

several places in the other anticlinal valleys. It exists in abundance in many regions, and particularly in the regions of the Mississippi river, where it has been most closely studied. It is known as the *Keokuck Limestone*.

The irregularity in the exposures above mentioned made it impossible to define the extent of these calcareous deposits, but they are evidently local. One of them in sec. 27, T. 13, R. 1, east, was estimated to be at least 80 feet thick. It is bedded on the Black Shale. This limestone is generally of excellent quality, much of it crystalline. It is apparently the best body of limestone seen anywhere in the valley, and will doubtless be utilized in the future.

The other deposit of this rock is in sect. 24, T. 14, R. 1, west. Its apparent thickness about the same, say 80 feet. Its base could not be seen, but as it was overlain by about the same amount of siliceous strata as the other, it was inferred that it had also the same base. The quality of the rock, however, is generally different; some of it is good, but most of it has too much silica and other impurities to be of economic value. A large cave opening down into the heart of this limestone, into the lower chambers of which a small stream sinks and disappears, is a noticeable feature.

DEVONIAN.

The Black Shale.—This is a thin but very persistent member, which marks the boundary line between the rocks of the Carboniferous era and those of the Silurian. Its average thickness is about ten feet, in some places less, and occasionally twenty, thirty or forty feet. It is highly bituminous, indicating an organic origin, and its included fossils are wholly marine. It is doubtless of Devonian age, and seems to have been deposited about the middle of the Devonian period. It probably belongs to the bituminous shales of the Marcellus period, or the overlying shales of the Hamilton period, as suggested by Prof. Tuomey.

SILURIAN.

1. *The Clinton or Red Mountain*.—This, with its varied strata and included iron beds, will be hereafter described in detail. It is generally regarded as the lower member of the Niagara period, and is the only representative of the upper Silurian in this region. Its average thickness in Murphree's Valley may be given at about 150 feet.

2. *Trenton and Chazy, Pelham*.—The *Trenton* is conspicuous and easily identified, wholly composed of limestone, over 250 feet in vertical thickness. At its base is a regular stratum, 20 to 50 feet thick, of light colored compact magnesian limestones. These lie conformably on the stratified quartzose rocks, of which the next thousand feet are mainly composed. Near the top of this great quartzose or chert member there is a peculiar conglomerate, and two thin limestone beds; they are by some geologists considered as representing the *Chazy* formation. The fossils however, of which there are many, have been considered by paleontologists as belonging to an earlier age. A very characteristic form of this horizon is *Maclurea magna*.

3. *Knox Dolomite*.—This is in many respects the most important of the older geological formations. It is over 1,000 feet in thickness, and forms the surface over the greater part of the anticlinal valleys of the state. Some of the most important of the beds of limonite or brown iron ore lie upon it. In its lithological characters this formation in Alabama is identical with the Knox Dolomite of Tennessee, as described by Dr. Safford. In its lower part it consists of limestones and dolomites of blue and gray colors, often especially in the lowermost beds, interstratified with shale. The disintegration of these beds gives rise to the fertile red lands which form the best farming areas of this and the other valleys. It is difficult to draw a sharp line of distinction between this lower part of the Knox Dolomite and the upper beds of the underlying Cambrian.

The upper part of the Knox Dolomite consists of gray

dolomites and limestones, all more or less charged with cherty matter, which occurs sometimes in great concretionary masses, sometimes approaching sandstone. The residual soils from the disintegration of these upper beds of the Dolomite, are usually of gray to yellowish color, and the surface is generally covered with angular fragments of the chert. Where the chert predominates, it often forms the ridges of gray flinty gravel which are so characteristic of this formation. The chert usually exhibits concretionary structure, and has small rhombohedral cavities interspersed through it, the empty moulds of crystals of dolomite which once filled them. This peculiarity was first pointed out by Dr. Safford, and seems to be fairly characteristic of the chert of this formation, though we have occasionally noticed it also in the Fort Payne chert. Other details will be given below in connection with the account of the brown iron ore deposits of this valley.

CAMBRIAN.

Coosa Shale, Sparry Limestone.*—The next member beneath the chert, or Knox Dolomite chert, as it is sometimes

*In the classification and description of the Cambrian rocks of Alabama, we are confronted with many difficulties. Dr. Safford has described the rocks of this period occurring in East Tennessee under the names Knox Shale, Knox Sandstone and Chilhowee, to which may perhaps be added his Ocoee group. In the eastern part of our Coosa Valley region we find the precise lithological equivalents of all these Tennessee divisions, and in the Report of this Survey for 1875, which relates to that section, we have identified and described the three types of Dr. Safford—the Knox Shale, the Knox Sandstone and the Chilhowee (Potsdam). Later, when we came to study the Cambrian of the valley regions along the Coosa river and westward, we found these divisions no longer applicable, for the sandy shales and their bedded sandstones, representing the East Tennessee, Knox Shale and Knox Sandstone, are replaced here by their bedded limestones with clay seams. So also we here find none of the great sandstone and conglomerate masses, which Safford named Chilhowee or Potsdam.

In many places east of the Coosa river these thin bedded limestones, to which we gave the name of Coosa Shales, appear to pass below the variegated siliceous shales of the East Tennessee type, to which we had given the name Montevallo or Choccolocco Shales.

We were therefore led to assign the Coosa shale to the base of this division; yet in Murphree's Valley and its south-western prolongation, we find sim-

called, is the *Sparry Limestone*. This member is wholly composed of limestone, with occasional thin beds of soft shale. The limestone is generally blue, and crossed with seams of Calcite or lime spar in all directions. It is a rock that has been noted and studied in many parts of North America. In the Canadian Survey it is called the "Levis Limestone;" by others the "Sparry Lime rock." Safford, in his Geological Survey of Tennessee, grouped it with underlying and overlying members, and called it "Knox Shale. More recently, however, the United States Geological Survey has definitely placed this rock in the scale as Upper Cambrian. And Prof. Walcott, Chief Paleontologist of the Survey, who has given much labor to the study of its fossils, draws the line between the Upper Cambrian and the Ordovician or Silurian, at the top of this rock, or rather *between this rock* and the clearly defined Silurian strata above, thus

ilar thin-bedded limestones with clay seams or bands *immediately below* strata of undoubted Knox Dolomite age. These shaly limestones underly usually level tracts of badly drained lands, to which the name "Flatwoods" has been given.

In consideration of the facts above named we were led, in the Preface to the Plateau Report, published in 1891, to the conclusion that the lithological variations in the Cambrian strata of Alabama were due, in the main, to geographic position; that while sandstones and sandy calcareous shales were accumulating along the eastern border of the Coosa Valley area, limestones, and alternations of limestone with clay beds, were accumulating further westward, presumably more distant from the coast line of that period; and that the "Flatwoods" limestones, with their inter-bedded clay seams, are the time equivalents, not only of the Coosa Shales, but also of the Choccolocco or Montevallo Shales and their included sandstones.

To sum up, the Cambrian of Alabama consists of thin-bedded limestones often with clay partings (our Coosa Shale or Flatwoods rock), passing downward into siliceous limestones and calcareous shales, which, towards the east, graduate into calcareous sandstones, alternating with calcareous shales (Choccolocco or Montevallo Shales), and enclosing, near the base of the series, great beds of sandstone, often conglomerate. The type of these sandstone masses is the Weisner Sandstone of Cherokee county, which is, I think, undoubtedly the equivalent of Dr. Safford's Chilhowee. These sandstone masses and the beds of calcareous sandstone near the base of the Cambrian seem to be confined to the eastern border of the Coosa Valley, while further westward in Wills', Murphree's, Opossum and Jones' Valleys the limestones with clay seams or partings are the only Cambrian rocks exposed.

E. A. S.

including this rock, and possibly some strata above it, in the Upper Cambrian. It is one of the most prominent formations exposed in this valley. In descending the valley it is first brought to the surface in Sec. 5, T. 13, R. 2, east. A few miles farther down, 1,200 feet of it is exposed. This deep exposure extends down to the Blackburn Fork of the Little Warrior. Below this it is less prominent; and it passes entirely beneath the surface in Sec. 12, T. 14, R. 1, west. It is barely seen at any point from here, to a little below Turkey Creek in Jefferson county. This rock is prominent in many parts of Jones' Valley, in the Cahaba Valley, and especially so in the upper Coosa Valley. It is occasionally brought to the surface in Will's Valley, but not in the Sequatchee fold, at least below the Tennessee river.

The amount of denudation that has taken place in the deepest parts of this valley is thus shown by these measurements and estimates of thickness of strata to have been about 5,300 feet, or a little more than one mile in vertical depth.

STRUCTURE.

It is, however, to the geological structure and mineral resources of this valley that the attention of the reader is specially directed, both on account of the peculiarities of the former and the importance of the latter.

THE GREAT ANTICLINAL FOLD.

Murphree's Valley, like the other Silurian valleys of North-east Alabama, is a valley of elevation; that is, a valley eroded out of the crest of an upward fold of the strata. It is not within the scope of this report to examine or enquire into the causes or processes of such folds, or such valley-making erosions. Upon these there might well be much difference of opinion among geologists, and the unprofessional reader would not be benefitted by mere speculation.

But as to the fact that these valleys have been thus produced, there is no controversy. Every one of them presents in its structure the most conclusive evidence of its truth that science can demand.

The most inattentive observer must have noticed that in these valleys the inclining rocks, the stub ends of their strata, are all dipping at some angle with the horizon, and in some definite direction towards one or both sides of the valley. And that if this dip of strata were extended outward and upward, it would describe or produce a fold overarching the valley; and possessing the form and volume which the fold would have had, if it had not been eroded. Thus the structure and contour of all folds, however much eroded, can be represented and studied, and ideally reproduced.

These upward folds of strata present in their different forms all degrees of flexure, from the incipient or symmetrical fold, with its strata dipping equally on each side from a common anticlinal axis to a completely doubled, or folded axis, lapped over to one side, with its strata all dipping one way, and hence called "monoclinal."

It has been shown in the Appendix to Squire's Report on the Cahaba Coal Field, that the valley separating the Cahaba and the Warrior Coal Fields is, in the vicinity of Birmingham, a double one, Jones' Valley proper on the east and Opossum Valley on the west. Both these component valleys exhibit the regular Appalachian type of structure, i. e., they are unsymmetrical anticlinal folds with the steeper side towards the northwest. The axis of the anticlinal is consequently found always near to the northwest edge of each valley, and over the greater part of the area of each the strata have a gentle dip towards the southeast, while the much steeper northwest dips are confined to the extreme northwestern edge of the valley. Very often the fold has been pushed or lapped over towards the northwest, so that the strata on the northwest side of the anticlinal axis stand vertically, or are pushed beyond the vertical so as to be reversed. When faulting occurs, as is very generally the

case, the southeastern limb of the fold has been pushed up over the northwestern limb, overriding and hiding from view a greater or less proportion of the strata on that side of the fault.

One who had examined the structure of the valley in the vicinity of Birmingham, would naturally expect to find that its prolongation northeastward into Murphree's Valley would not present any features essentially different; yet in Murphree's Valley we find the strata with gentle northwesterly dips occupying the whole of the valley except its extreme southeastern edge, where they stand either vertical or have been reversed and dip back towards the northwest, the very opposite in all respects to what has been described above as typical for the Appalachian regions.

The structure of Murphree's Valley is shown in figures 1 and 2, which represent sections across the valley, figure 1 near its head, and figure 2 in the central parts.* From the inspection of those figures, it will be understood that to the southeast of the valley lies the synclinal trough of Raccoon or Blount Mountain, with its strata nearly horizontal, but in reality gently sloping towards the northwest from the eastern margin of the mountain down nearly to the vertical wall, which makes the common boundary at once of these measures and of Murphree's Valley. *Straight Mountain*, as this vertical wall is called, is a part of the connecting limb between the synclinal of Raccoon Mountain and the anticlinal of Murphree's Valley. I say a part, for the great fault shown in the figures has cut out a greater or less proportion of the strata of this connecting limb. In the sharp bending back

*In constructing these sections to true scale, it has been found that some of the formations occupy on the surface considerably more space than the thickness of their strata, with the observed dips, would justify. This is particularly the case between the summit of west Red Mountain and the rim of Sand Mountain, where, with the average dip observed at many of the outcropping ledges (fifteen degrees to northwest), a thickness of 1,500 to 2,000 feet of subcarboniferous strata would be required. A liberal estimate of the thickness of these formations, derived from many actual measurements, would be 1,000 feet. We have thus been forced to the assumption that the dips of some of the beds below the surface is considerably less than that shown at the outcrop.

FIG. I. SECTION ACROSS MURPHREE'S VALLEY.
NEAR UPPER END.

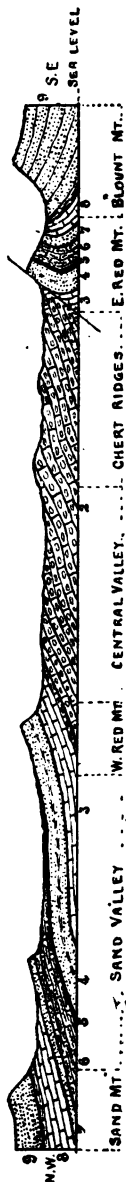
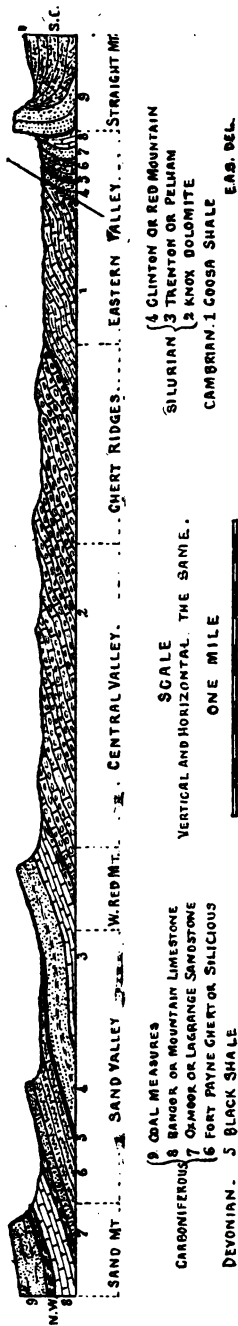


FIG. II. SECTION ACROSS MURPHREE'S VALLEY.
NEAR CHEPULTEPEC.



of the strata of this vertical or reversed limb, it was inevitable that there should have been a certain amount of shearing and displacement of the beds, and we should be prepared to find here evidence of minor faults, and of the squeezing out of certain beds in this upturned and broken part. In figure 1 it will be observed that the vertical wall does not exist, its place is occupied even by a depression, and there is very probably more or less of displacement and faulting between the reversed beds to the west of the depression and the gently dipping coal measures to the east of it. The strata in this depression are so covered by the broken fragments of the rocks which border it, as to make their examination almost impossible.

On the valley side of this vertical wall (fig. 2) a space of about one-fourth mile is occupied by formations 4, 5, 6, 7—all dipping at high angles to the northwest—all very irregularly exposed, and all *reversed or inverted*, the newer dipping and passing beneath the older. These formations are here very closely crowded together, often lapped over each other, often some of them completely hidden. In the aggregate they occupy only one-eighth of the space they fill on the other side of the valley.

On the northwest side of these inverted members, and closely abutting on some one of them, is the Cambrian limestone. A great fault exists here, but its position is recognized only by the abnormal junction of diverse formations. The dip of strata near the fault varies from 40 to 60 degrees to northwest, and gradually diminishes to about 15 degrees at the foot of Sand Mountain. Two miles beyond that, the northwestern dip terminates in the synclinal trough of the Warrior river. It is thus seen that from the fault at the southeast edge of the Cambrian limestone, to the northwest side of the valley and beyond, the fold is perfectly regular, and presents the appearance of one side of a symmetrical fold. This regular side embraces about seven-eighths of the entire floor space of the valley. It is in the remaining one-eighth lying between this fault and the southeast edge of the valley, that all the geological difficulties are found.

It is evident that there is not space enough on the south-east side of the fault to contain the counterpart of the strata on its northwestern side, in any form of fold that could be assumed. That large portions of the strata on the south-east side of the fault have gone down in it—been engulfed or folded under—is evident.

Their absence and the direct contact of the Cambrian strata on the one side with Clinton or Subcarboniferous on the other, indicate the position of the great fault. This fault extends the whole length of the valley but is not throughout of equal magnitude of displacement. Its greatest depth is in that part of the valley where the Cambrian limestone is exposed, above that towards the head of the valley it gradually diminishes in depth.

It is very generally believed that the structural features of the Appalachian region have been produced through the agency of a force acting from the direction of the Atlantic ocean, i. e. from the east and southeast, by which the strata have been compressed into much less space than they occupied in their original horizontal position. This lessening of the area was accomplished by folds and flexures and by the rupturing of the sharply bent strata and the sliding of one portion bodily over another portion. An examination of this region will show that in nine cases out of ten, the folds when not symmetrical, have been lapped over in the direction towards which the force was exerted, and where faulting occurred, the overriding portions were pushed or thrust up in the same direction, i. e. northwest. In Murphree's Valley all this is reversed, and we find the strata occupying such positions as they would normally have assumed under the action of a compressing force acting from the northwest, raising a fold, lapping it over towards the southeast, and after faulting thrusting the northwestern half of the broken fold in the same direction.

Inasmuch as we have no evidence of any compressing force acting from this direction, we must explain the peculiar structure of Murphree's Valley under the dynamic conditions which obtain in other parts of the state. This

structure can be explained under the supposition of a compressing force acting from the southeast, by assuming that the trough of the synclinal lying to the east of Murphree's Valley was lapped under the anticlinal of the valley, and when faulting occurred, the underlapped beds were *thrust under* those to the northwest of the fault plane. Thus while the arch of the fold of Murphree's Valley appears to have been thrust over towards the southeast, as if by a force coming from the northwest, in reality, the motion of the strata has been in the opposite direction, impelled by a force acting as in the other cases from the southeast, those beds whose lateral motion was greatest being thrust under those which yielded less in that direction, thus uplifting them into an arch with its steeper side, its fault and its reversed or overturned strata towards the south-east.

TRANSVERSE FOLDS.

In addition to the plicating effects of lateral pressure already considered, there has also been in this region a general, though less prominent, transverse folding of the strata. A flexing, faulting and wrinkling of all the formations at, or nearly at, right angles with the axis of the valley, or approximately in a south-east and north-west direction. Whether this system of flexures has resulted from pressure or other cause, whether the cause operated from the south-west or from the north-east, would be much easier asked than definitely answered. That it does exist as a widely extended system, slightly affecting the geological structure, and very distinctly modifying the topography, is a matter of daily observation.

These transverse flexures are more distinctly seen in the ridges and high lands, where their outlines are freely exposed. In some places they extend for miles, in others they can be

traced only a short distance. Some are mere swells or depressions, others constitute faults varying from a few feet to several hundred in depth. Every high point is found to be on one of these upward flexures; and generally every stream that cuts through the ridges, and every wind gap is on one of the downward flexures. They have doubtless greatly affected the drainage and erosion of the country, by offering ready-made outlets and passages for the waters.

In the mining operations on Red Mountain, these flexures and faults are found to be very numerous. In stripping down to bed rock, every few rods, or less, exposed one of these upward curves, even where the surface gave no indication of its existence. They are found to occur with considerable regularity, and generally show displacement of but a few feet. Yet they are so numerous that in the aggregate they plicate and shorten the country's diameter in a north-east and south-west direction, approximating that produced by lateral pressure from the south-east. The compression of the latter force was mainly accumulated in the valleys, while that of the former is diffused all over the country. The faces of all the ridges and mountain brows present the undulations and flexures of the strata. They present the appearance of successive earth waves, having undulated the earth's crust and left their form impressed upon its structure.

But in addition to those long undulatory waves, and the short and numerous choppy waves which have left their form and impress on the earth, there are others found far apart that have heaved up extensive tracts of country and depressed others, thus affecting drainage and topography. These might be termed earth tidal waves. They do not generally give steep or high elevations—they do not make conspicuous land-marks, yet they control the drainage of large areas of country, and have determined the flow and volume of the streams. Only brief mention will be made of these, as few of them are wholly within the area embraced in this report. The area of the coves north-east of Jones' Valley is one of these swells, from whence flows one of the head streams of the Cahaba to the south, some streams to

the west and north-west to the Warrior, and the main head of Canoe Creek, which flows east and north-east to the Coosa. In that depressed basin, where streams flow in from every point of the compass, it unites with the Coosa, whose whole course has been in the opposite direction.

This great swell whose highest points are in this cove region, extends east and south-east to the Coosa river, making a very well marked watershed, and west and north-west as far at least as the Warrior river. But a still more prominent and important swell, with the same south-east and north-west trend and extending more than half the breadth of the state, makes the great watershed between the Tennessee, and the Warrior and Sipsey rivers. From the eastern side of Blount county to near the western boundary of the state, a distance of more than a hundred miles, not a single stream crosses this divide. Even where the great Sequatchie fold was cut through it, near its south-eastern end, it still makes a very distinct watershed. Many other regions of elevation of less prominence, but with the same trend and apparently the result of the same cause, might be given, and many others which show the modifying power of both *lateral* and *transverse* pressure. But these are deemed sufficient to fix the reader's attention on this class of phenomena, and impress the fact that this force has been one of the main factors in complicating the structure, and shaping the topography of this region of country.

OTHER PECULIARITIES OF STRUCTURE.

Absence of certain formations on the south-east side of the valley.—Before proceeding to details, it may be well to notice some features peculiar to the south-east side and upper end of this valley. One of these is the entire absence of the Trenton limestone on that side of the valley.

A short distance below Village Springs is the last exposure of these rocks at the foot of East Red Mountain. From that point to the head of the valley, they are not exposed on that side. Opposite Village Springs, the lower Siluran chert and

Clinton come together at the foot of East Red Mountain; the Chert dipping steeply to the north-west, the Clinton steeply to the south-east. A fault here has engulfed the Trenton formation. Half a mile east of this point the Clinton is found near the top of the mountain, standing nearly vertical and trending nearly east and west; while a little to the south of it the Lagrange Sandstone makes the very top of the mountain, with a moderate south-east dip. One mile or less north from this latter point the Lagrange Sandstone is found at the edge of the valley in a massive vertical ledge, with lower Silurian Chert (Dolomite) lapped up on its north-west side. These things show that the uplift has been very irregular in this region; that it is traversed by faults running in different directions, which have broken the continuity of uplift and the sequence of strata. Their presence is always indicated by one or other of these results, and to their effects all such seeming anomalies of structure must be attributed.

Another feature that has already been referred to is the almost entire absence of the Carboniferous or mountain limestone on the south-east side of this valley. At only two points, in low gaps, have any of it been seen, while the underlying Lagrange Sandstone is generally very prominent.

Comparison of the ends of the valley with the central part. Near the upper end of the valley its south-east edge is Coal Measures, dipping steeply to the south-east. A narrow gorge separates this rim from a high ridge of Sub Carboniferous chert dipping 60° to 80° to the north-west. In its diverse dips and displacements this part resembles the Village Springs section, only newer formations are on top.

That there was less pressure on the reversed portion of the fold here, or at least less yielding to this pressure, than in the middle-portion of the valley, is evident from the fact that the reversed strata were here left standing at a much higher angle than there. It will be understood that to *completely reverse* strata their fractured ends have to be forced through an arc of 180° . These partially reversed strata have described an arc of 100° to 120° , lacking 60° to 80° of com-

plete reversal; while in the central portion of the valley they have described an arc of 135° to 150° , lacking only 30° to 45° of complete reversal. It is therefore reasonably concluded, that with less yielding to the lateral pressure and with less displacement in this portion of the fold, the absence of the vertical wall for a few miles may be considered as explained.

The Horse Shoe Curve of the upper end of Red Mountain is a striking and peculiar feature. It circles around the upper end of Red Mountain Valley, making a cove of its upper part, without materially diminishing its width. In its outer circle it closely approximates the curve of the end of the valley.

This peculiar topographical structure resulted from the effects of two distinct causes. 1st. A flexure in the main fault at the upper end of Red Mountain Valley—it there suddenly deflects from an east north-east to a north north-west course in passing through Red Mountain; but beyond that, again resumes its former course. Hence, the denuding waters were not aided by this fault in the excavation of this sub-valley above the deflexion of the fault to the west. Hard strata were encountered, and the further abrasion of this sub-valley to the north-east was arrested.

2d. Because the waters above and beyond this point found outlets along each side of the valley. These waters with their interlocking heads eroded the Red Mountain and its curved upper ends, and its adjoining Chert ridges on the outside, and were the main agencies in carving out its present form. But for the obstruction occasioned by the flexure in the fault at this place, it is more than probable that the denuding waters would have flowed down it, and eroded out the Red Mountain Valley to the head of the fold. The ends of Red Mountain and the Chert ridge would then have been left trending in the direction of the axis of fold, instead of being united together.

The end of the fold.—The head of the valley is the end of the fold to the north-east. All around its terminal rim the

dip of the strata is away from the axis of uplift. The fold ended where the valley ends. In the broad table lands beyond it there is no evidence of rupture or uplift. No ridge or fold or fault is visible;* there is no sign of disturbance save a gentle dip to the north west, in this long and broad expanse of table land, which extends from the end of this valley to the Tennessee river.

ECONOMIC GEOLOGY.

Having thus given a general outline description of the valley, showing its structure and the present arrangement of the various formations exposed, a detailed description of its minerals and materials of economic value will be better understood. Of these, iron ore is the most prominent. It exists in two forms, the *Red Hematite* of the Clinton formation and the Brown ore or *Limonite*, found at several horizons, from the top of the Cambrian to the base of the Coal Measures. They must be presented separately, and the Clinton demands the first place because of its greater importance.

HEMATITES OF THE RED MOUNTAIN OR CLINTON FORMATION.

The Clinton is the great iron bearing formation of Alabama and other states. It lies here conformably on top of the Trenton limestone, and is capped with the Black Shale. Its aggregate thickness varies from place to place, but generally approximates 150 feet. The upper twenty feet, however, contain no valuable seams of iron ore. A vertical section will show the average structure.

*The fault spoken of elsewhere as cutting through the rim at or near the head of the valley, cannot be followed very far beyond the rim of the valley.

E. A. S.

General Section of the Clinton Strata.

Black Shale.		
	Shaly and slaty beds, clay and some iron ore.....	15 feet.
	Heavy bedded sandstone, sometimes 40 to 50 feet, usually	10 "
No. 1.	Iron bed, ore lenticular or concretionary.....	2 to 4 "
	Yellow sand rock, soft, gnarly, no cleavage.....	10 "
No. 2.	Fossiliferous iron ore bed.....	6 inches to 2½ "
	Soft, dark, irony sand rock.....	7 feet to 15 "
No. 3.	Iron ore bed, varying greatly in quality.....	2 " 7 "
	Flaggy sandstone, shale and clay.....	20 " 40 "
No. 4.	Iron ore, hard, rough, pebbly or lenticular.....	2 " 20 "
	Dark grey sand rock, often massive.....	20 " 50 "
No. 5.	Iron ore, soft, fine grained, dark ore, often limy ..	3 " 20 "
Trenton Limestone.		

In addition to the five beds of iron ore presented in the section, there are often several others; but as they are not very persistent, and were found nowhere thick enough to be of value, or even of good quality, no notice has been taken of them.

This section only approximates the general structure and arrangement. To present it by accurate measurements from place to place, would require a very great number of sections. These, by their variances, would rather confuse than aid the reader. An average portion of the formation was therefore taken and measured, by which all other portions can be compared.

The variations in the Clinton are great and numerous; they embrace all its constituent members. The rocks vary in thickness and quality, in color and texture. The iron ore beds vary in number, and in quantity and quality of the ore; and these variations take place rapidly. No one mile of this formation is the exact equivalent, or counterpart of any other mile. This formation was by the older geologists well named "The Protean Group," because of its want of uniformity and the rapidity of the changes in its strata.

The Clinton is very prominently exposed in this valley. It constitutes the cap, or top member of the *Red Mountain*, the whole length of the valley, and it occurs in more or less broken sections, also on the south-east side. The *Red Mountain* standing as it does towards the north-western side of the valley, with its strata dipping north-west, gives generally on its south-east face an exposure of the whole thickness of the Clinton formation. From this face it dips at an angle of 18° to 20° down the north-west side of the mountain and beneath Sand Valley.

DETAILS OF OCCURRENCE OF RED ORES.

North-western Side of the Valley.

To give a consecutive description of this formation, we begin near the head or upper end of the valley, at the end of the eastern curve of Red Mountain. At G. B. Wade's, in the north-west quarter of S. 1, T. 11, R. 4, east, about 200 yards south of his house, and close to the Walker Gap branch of Bristow's creek, the Black Shale was seen, dipping north-west 75° or 80° ; about 50 feet west of it a bed of yellowish clay, and other strata indicating the Clinton formation. Three-fourths of a mile north of Wade's, in the south-west quarter of S. 36, T. 10, R. 4, east, at Mr. Boyd's, are several small openings in two seams of red ore, the cuts sufficient only to expose the tops of the seams. The eastern one sandy, dark ore, resembling the *lower bed*; the western one better ore—no fossils seen. The dip of the ore as seen in the cuts is nearly vertical, say 85° north-west.

One hundred yards or so, north of these cuts, the same seams of ore were seen in the road—trending *west* of north—and nearly vertical, and apparently dipping downward beneath a ridge of Sub-Carboniferous Chert—which begins at this point and lies to the north east. This ridge rises to a height of 200 feet and is composed wholly of Sub-Carboniferous Chert with its characteristic fossils. The Black Shale was not seen in the ridge; but its position is very clearly indicated by its usual accompanying rocks. These rocks stand mostly vertical, some dipping perceptibly east by south, others west by north.

East of the apparent place of the Black Shale, the manganiferous belt which lies above it, could be plainly traced, and the trend of the Clinton strata where last seen would place this formation in the foot of this ridge, to the west. This arrangement was now clearly seen in the north-west quarter of S. 25, T. 10, R. 4, east, at the apex or inner point of the curve of Red Mountain. Here the Clinton plainly shows on the *inside* (Valley Side) of the Chert Ridge, (Sub Carboniferous,) and extends over one-third of the distance up it from the base. In the extreme point of the curve, and at the line of the fault, a point of Clinton strata with the uppermost ore bed exposed and in vertical position, marks the top of the divide. There is a *bend here in the fault line*; it cuts the Red Mountain in a direction nearly north and south. Its line shows a deep depression which has been eroded by a stream that rises at this point and flows north. On the east side the Sub Carboniferous Chert rises 200 feet high above this point, and on the west, the Clinton Strata at about the same height cap the Red Mountain, with a dip of 30° north-west. The existence of this gap was not suspected before as it cannot be seen from any of the roads. It was further observed that the Chert Ridge here is over 200 feet above the base of the eastern rim of the valley—but the Sub-Carboniferous (Oxmoor) sandstone was not exposed anywhere on this side. The dip of strata of the Coal Measures of the eastern rim, is 60° to the east at this point, and for two miles further down, the dip gradually changing to S. E. and lessening in degree further down the valley—to increase again to verticality still lower down.

South-westward from the fault line Red Mountain is mainly composed of Clinton strata; with Lower Siliceous Chert overlying and covering its N. Western Side, and occasionally a little of the Trenton showing at its S. Eastern base. But few exposures of iron ore had been made by digging; one was in S. 25, T. 10, R. 4 E., on bed No. 3 General Section. This bed has usually a rock or clay parting at or near the middle, three or four inches thick. In this place it was rock, and the

cut had only been driven in far enough to show decomposed ore above the parting, and 18 inches of hard dark steel grey ore beneath it. It was inferred from the usual arrangement of this seam, that it carried here three feet of ore. This ore is limy and crystallized, but low in Silica—hence a valuable ore of iron, as it not only furnishes its own flux, but carries probably enough lime besides to flux an equal weight of soft ore. It can be very economically smelted in connection with certain other ores. This bed is of this quality in many places as will be hereafter shown.

Another opening on the same bed was found S. W. $\frac{1}{4}$ of N. W. $\frac{1}{4}$ of S. 35, same T., ore about the same quality, but not quite so thick. This was on the lands of J. H. Vanzandt. This opening like the former one had only exposed one half of the bed, and was not cut far enough in to show the full thickness of the seam, or a fair sample of its ore.

Outcroppings of iron were seen here, above, and below this bed, probably from beds 1 or 2, and 4, of the General Section. Owing to the smoothness of the face of the mountain the edges of the Clinton strata are not exposed—they are covered over deeply with earthy matter, making the positions of the iron ore beds hard to locate. The general absence of roofing rocks has caused decomposition of the ores near the surface. Enough surface specimens were seen, to warrant belief that the beds are all here, but the rocks are generally soft and shaly, and few of them come to the surface.

In S. 34, T. 10, R. 4, E., a large outcrop of iron limestone was seen—it carries very little iron, and no indication of a bed of ore was found in connection with it. It lies near the S. E. base of the mountain, almost at the level of the valley. It is evidently near the horizon of bed No. 5 of the General Section.

In the adjoining Section 33, higher up the mountain, several pits had been dug many years ago for iron ore, and beds 1, 2 and 3 of the General Section had been found. The excavations had not been made deep enough to reach good ore, or even to find the thickness of the beds. It was



only by examining adjacent surface specimens that the beds dug for could be identified.

The Red Mountain here is a broad flat topped ridge, with Clinton strata from below its eastern base to about two-thirds of the way down its western side, where Black Shale had been exposed.

Where the Sand Valley road crosses the mountain near Noah Nelson's, the Black Shale is higher up, near the top of the mountain. South of this point in a well sunk in the edge of the valley, (S. E. side of Red Mountain) a seam of iron ore was found.

The massive heavy bedded sand rock that usually caps the first or upper ore bed was not seen N. E. of the Warrior River. It is probably wanting in that part of the mountain. Its absence in part accounts for the smoothness of the mountain, and the great disintegration of the ore beds. From S. 33, T. 10, R. 4, E., to the Warrior River in S. 14, T. 11, R. 3, E., a distance of four miles, no openings were found on the ore beds, nor any out-cropping of ore. The Black Shale shows occasionally in place, near the top of the mountain, or on its north-western side, and the Clinton strata extend down into the valley on the south-east side. The Trenton rocks are not exposed—they are not even uncovered in the bed of the river. The whole of the mountain here is of Clinton strata—which are not largely composed of hard rocks. The iron bearing stratum is therefore thick. It hence seems probable that ore beds of corresponding thickness may exist here; yet nothing unseen can be certainly predicated of the protean strata of the Clinton.

Immediately on the southwestern side of the river, the Red Mountain becomes much higher. The Trenton is brought up by a rapid transverse flexure. In a little over a half mile, it has risen over 300 feet. Its lower stratum, the yellowish magnesian lime rock, is seen over fifty feet above the level of the river. For a short distance the Red Mountain is abnormally high. This flexure is short, only about a mile in length. In the town of Walnut Grove, one mile from the river, the top of the Trenton rocks shows in the

streets, dipping at a small angle to the northwest. And opposite this place, where the Blountsville road crosses the mountain in S. 22, the top of the Red Mountain is sunk down in a gap, only about 40 feet high. This gap shows only Lower Siliceous rocks—the Clinton being sunk beneath the level of the valley. In the space of a little over a mile, the flexure has been up, and then down again, each, more than the whole thickness of the Trenton strata. Nearly opposite this high part of the mountain, in S. 15, on its N. W. side, in the Lower Siliceous formation, is the first important out crop of manganese. It continues to show for several miles along that side of the mountain. The manganese will be described in its proper place; but it may be here remarked that in that section of the mountain that carries manganese, there seems to be less iron ore, and of quality generally inferior to the average; that there could be any relation between the iron, and manganese, seems very improbable, and this fact is here merely noted. Several openings have been made into the iron ore, in the next three miles S. W. of Walnut Grove. Only the top bed, or No. 1, was found, and the samples obtained were inferior.

A very heavy bedded massive sandrock, begins now to occupy the lower portion of the Clinton. It was first seen a few miles below Walnut Grove, and gradually increases in thickness. It takes the place of the dark yellowish gnarly rock, near the base of the General Section. This rock continues, about to the west line, of T. 12, R. 2 East. In all this space ore beds Nos. 4 and 5, were not seen, and are not believed to exist, certainly not in sufficient quantity to be of value. All the ore that has been seen in this space therefore belongs to one of the three upper beds.

In Sects. 1 and 2 of Tp. 12, R. 2 East, was the first place found below Walnut Grove, that gave indications of good ore. Several openings had been made on bed No. 1. The ore is wholly concretionary, of rather low grade, but uniform in character. At all the openings in these sections, the thickness of the bed varied, from 2 feet, to 3 feet, averaging about 30 inches. Bed No. 2 was not found here, and the

position of No. 3 did not seem to have been known to the prospectors. Its outcropping was found here, and pointed out. This bed usually shows very little out-crop but its position may always be closely approximated if bed No. 1 is found. It lies by the usual slant of the mountain, about 50 feet lower down. The color of the ground at its edge, will also help to determine its exact position.

Without knowing the thickness of bed No. 3, and the quality of ore it carries here, it would be premature to decide finally on the value of this, as an ore region. It may be here the best bed, as it was found to be farther down the mountain. In Section 11, same Township, similar openings had been made with about the same results, but here also the third bed had been overlooked. In Section 15 of the same Township, the upper bed had been opened; ore of the usual quality, and thickness say 3 feet, and assaying from 35 to 40 per cent. iron. This is about the average grade of bed No. 1 as seen for several miles above here. The third bed had been slightly opened here, but not enough to fully show either its thickness, or quality. It seemed to be thicker than the upper bed, and the ore promised to be better. It carries soft, fine grained, red colored ore. This bed is often limy and hard, but at no place from Section 1 to Section 21 in this Township was it found of that character. None of the openings on this bed in this space were deep enough to furnish samples, from which the quality of the ore could be safely determined, nor even to show the full thickness of the bed. This was judged to be about 4 feet thick, and to carry the best ore that this part of the mountain affords.

The upper part of the mountain here is shaly and has suffered much denudation; several gaps are cut through it, down to the Trenton rocks, and the edges of the Clinton strata beyond are covered with debris so as not to be readily found. It is certain however that two beds of ore exist here, of fair quality, and good thickness. Half a mile to the S. W., near Hoods X Roads in S. 15, several openings were examined. Bed No. 3 had been cut, in a pit sunk in a field,

and again filled up, it was said to be 4 feet thick, very soft ore. It was not roofed in with rock here, and probably the ore was much decomposed.

In the N. E $\frac{1}{4}$ of S. 16, same Tp., several openings had been made in the upper bed, it did not come up to the average here, either in thickness or quality. The mountain here is heavily capped with Lower Siliceous, cherty strata, and the heavy sand rock that caps the upper iron ore bed, is very thick. It seems to be the case, that where this cap rock is unusually thick, the underlying iron ore beds are thin. No reason is apparent why this should be so—it is a co-incidence, however, that has been noticed at many places. In the remaining portion of S. 16 that lies N. E. of the Calvert fork of the Little Warrior, persistent efforts have been made to expose all the beds of iron ore. If any one of them is not fully shown up it is No. 3. The upper bed is nearly three feet thick, composed wholly of concretionary hard ore, of light brown color, and very much resembling spathic iron ore, or clay iron stone. It is of very low grade, about 30 per cent. of iron. No. 2 was not found; it is not believed to exist here—nor has it been seen for several miles above this place. Six feet below the normal place of the 2nd bed, is a thin bed of purple colored ore, one foot thick. It is not only peculiarly colored, but it also carries fossils of *Cyathophyllum*, and allied corals, and is speckled, and streaked, with crystals of carbonate of lime. This bed has not been seen at any other place. Of course it is not thick enough to be of value, even if the ore were good; and is only interesting because it is rare and very peculiar. A small bed about the same size as this, is sometimes found between the 1st and 2nd beds. But it is not persistent, only occasionally intercalated. This one probably only runs a short distance—intercalated between the 2nd and 3rd; or the 3rd bed may have become divided at this place, this being the upper member, though the former opinion is most probable. The distance between it and the 3rd bed is too great, we think, to justify the latter opinion.

An opening was also made on the 3rd bed; it carries clean

solid ore, of low grade, only one foot thick. Some doubt is entertained about the identity of this bed, the surface measurement showed it to be near the normal place of the 3rd bed, but the ore resembled the 4th bed, and did not correspond in texture with any other portion of the 3rd, which has been examined. Yet neither could it be classed as the 4th, because the exposed strata showed that it did not occupy the proper position. A short distance beneath the usual position of the 4th bed was seen a bed of iron limestone 18 inches thick, but carrying very little iron. Immediately beneath this iron limestone comes the hard, massive sand rock, heretofore described. It shows here a mural face 12 to 15 feet thick, with thinner members extending down to the Trenton. It is evident that no beds of iron exist in, or beneath this rock. This is the equivalent of the lower yellowish gnarly sand rock near the base of the Clinton. But instead of being 15 to 25 feet thick, as it usually is, it is here, and for several miles above, and below this place over 40 feet thick. It is a matter of surprise that here, for a space of 12 miles (from S. 21, T. 11, R. 3 E., to S. 36, T. 12, R. 1 E.), only the upper half of the Clinton carries iron ore, while the lower part, not only carries no iron, but is composed of abnormally hard, massive rocks, often pebbly, or conglomerate, and hence more resembling the rocks of the missing Medina, or Oneida, than those of the Clinton formation. It is one of the many unaccountable changes that occur in this "*protean group*," as it still might well be called.

If any bed remains unopened here, it must lie beneath the third opening and the iron limestone. It is barely possible that a bed may exist there, though none is indicated on the surface. The Clinton is thicker than usual at this place, and would therefore have been expected to carry more iron than is yet seen. A little further to the S. W., N. E. part of S. 16, and near the rim, other openings had been made to further test the ore beds. No. 1 showed a little improvement in quality, though still spathic in appearance, a carbonate of iron and heavily charged with silica. The bed classed here, as No. 3 had materially changed; it was here 18 inches thick, soft and shaly and sandy; its purple color had changed to a

light brown, and no fossils or lime crystals were seen in this opening.

The strata at this place dip 15° N. W. and 18° S. W., showing a downward flexure across the axis of the mountain. This doubtless invited the streams which form the Calvert Fork of the Little Warrior to unite here, as they do, and cut through the Red Mountain.

On the S. W. side of this stream, and in the same section (16), but near its southern side, two openings had been made on beds 2 and 3. They showed a little improvement in the quality of the ore, but no gain in thickness. These beds are not roofed with rock here, and the ore which was reached was much decomposed. This section is evidently not favorable for mining, so far at least as yet tested. No. 1 was at this place entirely washed away. The existence of bed No. 2, which had not been seen for several miles, indicated improvement in a S. W. direction, though as yet it carried but 10 inches of ore. No. 3 was still only 18 inches thick, but was evidently improving in quality.

The Red Mountain occupies most of the N. W. $\frac{1}{4}$ of S. 21, the S. E. face is rough. The Trenton limestone is again seen half way up the mountain. Outcrops of iron were seen, but no test holes had been dug in this section, and owing to slides on the face of the mountain, the outcrop, or indications rather, of iron could not be relied on to identify the beds. Near the line of sections 20 and 21, same Tp., several test holes had been sunk. No. 3 was cut near the top of the mountain—ore limy, hard, crystalline, dark gray in the bottom or lower bench, and soft red colored ore, partly concretionary and partly lenticular, in the upper bench. The whole thickness of the bed, four feet, with a rock parting in the middle of three inches thick, and two clay partings in the soft ore—total thickness of ore three feet. A total change in this bed, in the last half mile. It has more than doubled in thickness, and totally changed in character of ore; yet there is no question of its identity. Bed No. 1 had been opened near the same place, on the very top of the mountain. It showed 30 inches of concretionary ore, not so good

as the bed generally carries, but considerably better than in section 16.

In the N. W. $\frac{1}{4}$ of the S. W. of Sect. 20, same Tp., another opening had been made on the third bed, now almost at the top of the mountain. The soft ore bench had been replaced with hard limy ore, the same as the lower bench. The bed showed a face of four feet, with a parting of yellow shale and iron clay 17 inches thick in the middle—solid ore 31 inches. Ore dark steel gray, limy and crystalline. From analysis of similar ores, it is judged to run from 15 to 25 per cent. of metallic iron. This ore could not be profitably smelted alone, but mixed with soft ore, for which it would furnish the necessary flux, would be economical to the extent of the cost of the flux at least.

About 200 yards west of the last opening, and beyond the top of the mountain on the same tract of land, an opening was made on the second bed. This showed a face of 30 inches of solid, good, fossiliferous ore. This is an unusual thickness for this bed; it rarely exceeds two feet, and is generally less. This bed usually carries the best ore, generally assaying about 50 per cent. of metallic iron, and holding less than one-third of one per cent. of phosphorus. At this place the average of the bed was judged to carry 48 per cent. of iron. The practiced eye can judge very closely of the amount of metallic iron a specimen contains, but the phosphorous cannot be seen. It is *always present* in iron and its ores, but the *amount* of it can only be determined by chemical analysis.

At this place the Trenton limestone is pushed up very high in its upward curve, and the upper part of the Clinton is denuded back, and therefore crops out on the N. W. slope of the mountain. A short distance to the S. W. these members assume their normal position, and the whole thickness of the Clinton, at least to the first iron bed, is exposed on the S. E. side.

In the S. W. of the S. W. of Sect. 20, same Tp., some partial openings had been made on beds 1, 2 and 3. Each of

them showed ore of good quality, but they had not been dug deep enough to show the thickness of either of them. A good show of ore could be made here with little labor. Fifty feet by slant surface measure, extended (as is usual) from the top of No. 1 to the base of No. 3, thus including three ore beds in a vertical depth of twenty feet. Should these beds be here of usual thickness, they would aggregate over nine feet of ore. Hence nearly half of this portion of the Clinton is iron ore.

Two hundred yards west of these openings another and larger one was made on the third bed. This exposed a face of ore 4 feet 8 inches. This ore is of good quality, soft fine grained, color dark gray. It is very remarkable indeed that the ore beds, especially this one, should change in volume and quality so much and so rapidly. In less than a quarter of a mile we have seen it increase one-half in thickness, and change from dark shaly ore to hard limy ore; then in another quarter of a mile increase twenty-five inches in thickness, become free from lime, soft, pulverulent, and of good quality throughout. Changes in this bed are not usually so rapid or so great, yet it is the most variable bed of this formation, and has never yet been found exactly the same for any great distance.

On the E. $\frac{1}{2}$ of N. E. $\frac{1}{4}$ of S. 30 T. 12 R. 2 E. is a very fine exposure of bed No. 1. A partial opening had been made on it, but evidently not at the thickest place, or on the best part of the bed. The opening however showed about four feet of ore. Fifteen feet slant surface measure reached from the top of this bed to the out-crop of No. 2. Both beds are therefore comprised in seven feet vertical. The second bed was only 12 inches thick, but the ore excellent, would assay about 50 per cent, the top bed 42 to 45 per cent. Both beds could be very advantageously mined together, as there is only a soft shaly parting of two feet between them. It was very evident that a little farther along the mountain to the N. E. the out-crop showed the bed to be heavier than where it was opened and samples of ore were seen there of higher grade than any seen in the openings.

Near the middle of this section (30) several small cuttings had been made on these beds. No. 1 showed 30 inches of ore, partly concretionary of a deep rich red color, partly lenticular, and partly rough or coarse grained ore; it was estimated at 45 per ct. of iron. No. 2 showed good ore as usual. No. 3 had been opened only enough to show the upper bench, which was 30 inches thick, ore soft dark grey. This bed is usually, if not invariably in this region, in two benches, of about equal thickness. From the exposure made, this bed was judged at this place, to carry 60 inches of ore.

No other openings were found on this bed for several miles farther down the mountain. Its position and importance are not generally known. It very seldom shows much on the surface, and therefore requires close observation to determine its position, if that be not already known. The existence of this bed was not known, till the writer pointed out its position, and made openings on it, a few years ago.

And yet in many places it is the most important bed in the Red Mountain. For the last two miles we have seen it to be the heaviest, and most of that distance carrying 40 to 45 per cent ore. Below this place for several miles, only the 1st and 2nd beds have been opened.

In the S. W. $\frac{1}{4}$ of S. 30, T. 12, R. 2 E., numerous little pits had been dug on the upper bed, or No. 1; all showed a good degree of uniformity in thickness and quality. Measurements were made of each. They ranged from 30 to 36 inches of ore, and in quality will approximate 40 per cent. of iron. It is, and has been for miles above here, almost wholly concretionary ore. Perhaps this term may require explanation. It is a form of ore that is not common elsewhere, and is only possessed by this bed in its course through Township 12 of Range 2 East. This ore has been called *concretionary*, because it is formed in masses of various sizes, each apparently around a *centre or core*. These masses are built up of *concentric coats* around this central core. These masses are of irregular shape, owing to the manner of compacting in the bed; and a large mass will generally contain several smaller ones inclosed in its con-

centric layers. The ore is generally of fine grain, and clear red color. The only defect apparent in this ore is a small lump of fine earthy, or aluminous matter, that generally forms the core of each concretion. These, however, are not considered of sufficient volume to interfere with the successful reduction of the ore. This form of ore is sometimes known by the name of "pot ore" among miners, and is generally regarded as a high grade ore, and easy of reduction.

In S. 36, T. 12, R. 1 E., the ore changes rapidly, and becomes sandy and coarse, and is therefore of little value. Near the centre of this section is the highest point of Red Mountain. The top of the mountain is here by Aneroid measurement 450 feet above the valley, and by the railroad survey, the valley opposite to it is 850 feet above the Gulf. The top of this point is therefore 1,300 feet above Sea level. One hundred and fifty feet of its upper part are Lower Siliceous Strata. A short space below the Black Shale comes an immense thickness of the sand rock that caps the upper iron ore bed. This rock is usually about ten feet thick, here it is fifty. At only one other place, in S. 16, T. 13 of R. 1 E., does this rock show such abnormal thickness. But the most abnormal thing noticed here, was the smallness of the iron ore beds. A good natural exposure of the bare rocky face of the mountain on the S. E. side, gave the outcrop of the ore beds, as follows:

Bed No. 1.—8 inches.	}	The 3 upper beds aggregate 1 foot of ore.
“ 2—2 “		
“ 3—3 “		
Bed No. 4—00 “	}	Wholly wanting.
“ 5—00 “		

These measurements were taken beneath the highest part of the mountain. No seams of clay, or soft shale, exist between the little iron ore beds, or elsewhere on its naked face—nothing but hard rock. The iron ore beds were comparatively close together, and were only identified by their succession. Farther down the mountain, ore bed No. 1 was easily traced, it gradually thickened from the middle of the mountain, towards the S. W. side, where it measured 30

inches. The quality of this ore is generally very poor; a few inches at the top of the bed is better than the balance, but even this is very low grade.

At the S. W. foot of this high point, there is a peculiar feature. The strata are flexed downwards so much that the Clinton is beneath the level of the valley. It has disappeared, and immediately behind its place the Lower Siliceous rocks alone make the mountain, which thus continues unbroken. It presents the appearance of a great sink in the mountain, though probably a cross fault exists here. None of the edges of the strata being exposed, so as to show displacement, it cannot be positively stated that this is the fact. But several irregularities near here, and along a North and South line crossing here, show unusual disturbance. About one-fourth of a mile south of this sink is a ridge trending southwards, in part composed of Clinton strata, with Trenton rocks intervening between it and Red Mountain. A little over a quarter of a mile north by west from this place, on the western foot of the mountain, there is a lone peak of Coal Measure rocks, nearly 100 feet high, with Carboniferous lime rock at its base. It stands alone nearly a quarter of a mile from Sand Mountain, with the narrow Sand Valley between. About one mile from this sink, north, is a ridge rising 250 feet above Sand Valley, and trending across it in an E. and W. direction. It rises up steep and narrow, its top only 20 to 30 feet broad. It is mainly composed of broken up Lagrange Sandstone, with Lower Siliceous shales at its base, but its strata do not appear to have the usual dip. So far as could be seen its strata are horizontal, or incline a little to the N. E. This was mainly shown by a thin stratum of red chalk iron ore, almost at its top. This stratum, about six inches thick at the western end, increases to nearly two feet at the eastern. It runs nearly horizontal in that direction, but showed a slight dip to the northeast. This stratum of iron ore was often seen and traced in the Sand Valley, among the upper members of the Lagrange (Oxmoor) sandstone. This sharp ridge had evidently been forced up at least 250 feet above its

normal position—and coincides in no respect, either with the axis, or general uplift of the valley. Almost opposite the western end of this ridge a gap exists in the Sand Mountain, and nearly due South from that is the sink in the Red Mountain, and across the valley still South is Clowdus' Gap in the Straight Mountain. It the reforeseems probable that all these abnormal features here may have resulted from a fault running North and South, with diverse displacements.

This sink in Red Mountain is in S. 1, T. 13, R. 1 E., half a mile West of Oneonta. Very little iron ore comes to the surface in this section. It is generally buried too deep under the Siliceous chert to be seen, or perhaps ever to be made available. In Section 2 adjoining on the west, good out crops of the top bed are seen all along the face of the mountain. Cuts were made in this bed at two places, in this section, and the ore found of nearly average quality, 31 inches thick at one and 36 at the other. Near the middle of Section 2 there are two gaps in the Clinton close together; between them, a point much denuded, showed the strata very plainly. The top bed, or No. 1 of the general section, is three feet thick, No. 2, 10 to 12 inches. No. 3 shows plainly, but was not opened. No. 4 carries soft, dark grey ore, and iron limestone, alternately. It was only very slightly opened, and sectional measurements could not be made. The whole thickness was estimated at ten feet, of which two feet of good, soft ore were exposed. The iron limestone is of good quality, and carries more than the usual per cent of iron. The 5th bed does not exist at this place. The indications however show that it begins a very short distance below this point, and continues for several miles down the mountain. In the remainder of Section 2 no openings had been made, but beds 1 and 2 crop out all along near the top of the mountain.

In Sect. 10, same Tp., several pits were sunk in the ore beds, and gave the following measurements:

Bed No. 1. Four feet one inch, with a two inch clay parting in the middle, about average quality.. Intercalated bed, one foot, reddish hard ore.

Bed No. 2. Fossiliferous ore, one foot excellent ore.

Bed No. 3. Face 7 feet, ore dark steel grey, in two benches with a three inch rock parting; also an iron clay parting near the middle of the upper bench, believed to be only the decomposed ore, which would soon become solid. Most of this ore is soft, with occasional blocks hard in the centre, indicating the presence of some lime in the bed, which would rather enhance than diminish its value. This bed is thicker here and more promising than at any other point yet seen on Red Mountain.

Bed No. 4 was here only opened enough to show its existence. It appeared to carry soft dark colored ore, in connection with iron limestone, as seen in section two, but is probably not so thick as estimated there. An opening had been made to reach bed No. 5, but only displaced samples of its ore had been reached. These were found scattered in the clay in pieces of 5 to 15 pounds weight. No other samples of ore were mixed with them. They differed greatly from the ore of any of the overlying beds, and closely resembled in color and texture the ore of the fifth bed. No doubt is therefore entertained of the existence of this bed at this place. And the relation of the underlying Trenton to the exposed cap rock of the bed, would indicate it to be thick. This is the first clear evidence of the existence of this bed that has been shown below the Locust Fork of the Warrior. And it was seen at only one place above that. It is not believed to exist between Sect. 2, T. 13, R. 1, and S. 14, T. 11, R. 3, East. But from Sect. 2 to S. 30, T. 13, R. 1, E., evidence of its existence has been seen at many places.

The ore of this bed may be distinguished from other ores by its fine grain, soft texture and dark color. Its position is at the base of the Clinton, and it is therefore deeply covered by the debris from above. There are therefore few natural exposures of this bed, and hence it is less known than any other. Its presence, however, may be generally known by a bench occurring just above the Trenton. This bench has been formed by the wearing away of soft material. If the

hard rocks of the Clinton are bedded directly on the Trenton limestone, no such bench has been formed. But if a large bed of soft iron ore and its associated soft shales exist there, they were readily eroded away back from the edge of the Trenton, and this erosion would generally be in proportion to the thickness or softness of this stratum. The debris, or talus from above being spread over this bench, has buried the edge of the abraded bed many feet deep, and it hence makes no out-crop. Even the great exposure of this bed near Village Springs (hereafter to be described), was not a natural exposure; but the result of cutting a drainage ditch on the side of the public road. The water soon cut down into the soft iron ore and exposed a sight which thirty years ago was covered up by several feet of earthy matter. This bench at the lower edge of the Clinton is generally broad and well marked from the middle of section two to the corner of section 16, in this Township, and several points farther down. It again becomes prominent a mile above Village Springs, and continues to Village Creek.

Near the middle of S. 10, T. 13, R. 1, E., the Trenton limestone is flexed downwards beneath the level of the valley. The flexure is short; it regains its normal height again in half a mile. Mill Creek cuts the remaining strata of the mountain at this downward curve. This flexure crosses the valley, as has been already noticed in the description of the Carboniferous Limestone. It therefore opens a way of easy access to the coal fields on either side, and through all the sub-valleys, and makes this place peculiarly well adapted for the manufacture of iron. All the needed raw material could be concentrated here, more economically, than at any other point in the valley.

Through the remaining portion of this section the upper bed of iron ore crops out boldly, and occasionally the 2d and 3d beds are seen. This is also the case in N. W. $\frac{1}{4}$ of sect. 15. The surface indications show that ore is abundant, and that probably all of the beds exist here.

In section 16 several openings have been made on the upper bed. It is more exposed and easier found than any

other, and has therefore received the most attention. At the several openings it measured usually three feet; some places an inch or two, more or less. It shows here a more uniform thickness, and is less variable than farther up the mountain. In grade it is two to five per cent. lower than in sections 10 and 15. It gradually lowers in grade through the remainder of section 16 and S. E. of 17, and N. E. of 20. The 2d bed also diminishes in thickness; at several places it was found only two inches thick. The 3d bed was partially opened at one place in S. 16, only two feet of shaly red ore was found. Either this bed was very much diminished, or the location was not a favorable one to show it. Below this place it has not been seen, and no digging has been done to find it.

The main supply of ores for several miles is now found in the lower beds. In the N. E. $\frac{1}{4}$ of S. 17 the 4th bed begins to show prominently on the surface. It here is two feet thick, solid, hard, coarse ore, heavily weighted with sand. Below this, and throughout Sect. 20 it is evidently thicker, probably three feet. Its out-crop is covered by debris from above. Almost innumerable slides have carried large sections of the bed down below its normal position. These have followed each other down to the limestone; sometimes to the foot of the mountain. Each one has carried huge blocks and masses of this bed along with it, and thrown them heaped and piled along the face of the mountain. These blocks are of all sizes, from a few pounds to more than ten tons. One block was measured which contained 220 solid feet of ore. These blocks are nearly as hard, and as little affected by exposure, as the sand rocks of the mountain. From the east line of Sect. 20 to the west line of the Township, there is a greater show of iron ore on the surface than anywhere else on Red Mountain. But it is sandy, low in iron and high in Silica. It is confidently believed that the 5th bed exists here, and that it carries iron ore of a better quality. Some specimens were found on the face of the mountain that seemed only referable to the 5th bed. But its position is so heavily covered by the slides from the 4th bed, and other-

debris, that it would require a great deal of labor to expose it.

In Section 30, same Township, the hardness of the ore from the 4th bed and the size of the displaced masses of it seem rather to increase. Careful search on the most abraded points was here made for the other beds. No. 3 was found, and as far as could be judged by the surface, is from 3 to 4 feet thick; ore rather too shaly near the surface, may carry good ore farther in. No. 2 was not found. No. 1 is thinner than heretofore seen, and inferior.

The Blackburn Fork of the Little Warrior cuts through the Red Mountain near the middle of this section. On the face of the mountain, on the South side of the river, the displaced blocks of hard sandy ore from the 4th bed are encountered. There is so much of it that it seems improbable it should all have come from one bed, only 3 feet thick. But it has. At the top of the mountain it is washed naked, and in place, and measured just 3 feet. A little farther along, the abrasion of a powerful current is very plainly seen. It had cut down the mountain below this bed, and carried the huge blocks of ore far down on the N. W. side. For a wide space the whole of the Clinton had been swept away. How strange that that little stream, now flowing 300 feet below, should ever have flowed here! Yet it had, though then the mountain was not so high. If it had been, the course of the stream would have been changed. It would have flowed down the valley to a different outlet. Plain proof here, were any needed of the gradual rise, and gradual denudation, of these barriers. Their uplift, and abrasion, went on together, and the course of the stream was unchanged. How long since the last uplift, we may never know, but it was evidently at no remote period of Geologic time. The principal falls in all the streams which enter, or leave the valley, *are yet at the margins; at its very edge.* These must recede farther, and farther up the streams, under their constant corrasion, until the fall in each is equalized. Bars of hard rock are slowly cut by running water—but these falls are all in Carboniferous rocks, which are readily abraded. It is therefore evident that the period since the elevatory

movement ceased, (if it has yet ceased,) cannot have been a very long one, or these falls would have been farther up the streams.

In Section 31, same Township, the 4th bed continues to be the most prominent. It still carries hard ore, but has less silica than near to, and beyond the river. It is evidently improving in quality, but has not diminished in thickness. The top bed which, for some distance back, had been abraded from the top of the mountain, and its out-crop buried by the debris on the other side, is again seen on the top of the mountain. Its thickness is less, and its quality inferior to what it is toward the North-east corner of the Township. About the same as it was seen in Section 16. Though it is probable, that at and near the out-crop here, for want of roofing in with hard rock, a fair sample of the bed has not yet been reached. Only a small portion of this section is on the Red Mountain, and the Clinton enters the next Township near the North-east corner of Section 1 of Township 14.

In T. 14 of R. 1 W., the Clinton presents much variation, and will have to be described in detail. In S. 1 the 4th bed is still the most prominent. In some places great masses of it have slid far down the mountain, and are thickly strewn along its South-eastern base. The ore is softer than we have seen it in Township 13, but yet carries too much Silica. It is estimated to contain 30 to 35 per cent. of iron. The 3rd bed was not seen here. And the 1st and 2nd were of little importance. In this Section the iron limestone, which has been found occasionally, as a thin member, in the Township above, now begins to thicken, and become prominent. In Section 11 it occupies a large space. Its thickness where seen to the best advantage, was about 50 feet. It all carries some iron, but it is unequally distributed. Some portions of the edge have much more iron than others, in some parts it is streaked with hard carbonate of iron and sand. All of it here has much sand, which will probably render it unfit for furnace use. It would make a very pretty building rock, but its hardness and grittiness would make it very difficult to dress, and it would not be durable. The iron and lime of

this rock both dissolve freely, and wherever it comes to the surface the face of the mountain and the bottom lands below are of a deep red color. Any one can tell from this, as far as it can be seen, where this iron lime rock is exposed in the mountain. It is continuous from here to Village Creek.

Careful search was made for iron ore beds in this section but none were found. In Section 14 a thin bed of ore was observed about 1 foot thick. It was believed to represent bed No. 1.

In the next Section (15) the bulk of the iron lime rock is greatly increased. It forms the bold, steep, bluffy face of the mountain. Where it is the most massive, it was too steep to be measured. Its thickness was estimated to be over 100 feet. At its base it was conformably bedded on the Trenton Limestone, and its naked top frequently makes the summit of the mountain; thus seeming to have absorbed the whole of the Clinton. If any Clinton strata lie above it at such places, they will only be found far down the western side of the mountain. None of the upper beds were seen in this section, and the material of the 4th bed is probably scattered through this immense iron bearing rock. Indeed it would seem that all the material of the Clinton formation had here been compounded together. The irregular distribution of these materials, especially noticeable in the iron streaks, gave it the appearance of having been deposited in agitated swirling waters. This hypothesis is not positively asserted, but the want of conformity in the arrangement of its streaks, the inharmonious arrangement of materials, and the semi-concentric rings everywhere seen in its structure, strongly suggest this opinion. At least this description will convey a tolerably clear idea of its structure in this section, and the one above.

In Section 22, same Tp., the volume of the iron lime rock has sensibly diminished. It no longer reaches up to the top of the mountain. From fifty to one hundred feet of Clinton strata are occasionally found above it. In one of these points or knobs capping this rock was found an excellent out-crop of the ore of bed No. 1. It was a matter of much surprise to

find it carrying first-class ore at its first visible out-crop. The bed had not been opened; its thickness seemed probably two feet. This is in the N. W. $\frac{1}{4}$ of Sect. 22.

The trend of the mountain here embraces the eastern and S. Eastern [portions of Sect. 21. Beds No. 1 and 2 became prominent. At one place where they were seen to the best advantage, the second bed was based upon the iron limestone. A thin parting separated it from the first bed. Both were practically one bed. They measured four feet face at the out-crop. Two large areas of the upper bed had been washed bare; the overlying strata all removed and vast quantities of the ore were thus exposed on the top of the mountain. Farther from the edge these beds evidently thickened. The dip to the N. W. was less than 12° . The beds therefore descend the mountain on its N. W. side near the surface. It was seen at the surface in Sand Valley, half a mile to the N. W.* A vast area of available ore exists here. It will mainly have to be got out by stripping off the loose surface. It is not capped by solid rock, and the surface stripping will be less expensive than mining, while the quantity of ore that can then be raised per hand will be vastly greater. This is probably the largest body of available red hematite ore that exists in this county.

These beds of ore, Nos. 1 and 2, were traced and closely examined from the Eastern side of Sect. 21 to Village Creek, in the Southern part of Sect. 28. It may be here remarked, however, that in Sect. 28 they dip to the S. W. as well as to the N. W., and here descend rapidly far beneath the top of the mountain. At the South line of S. 28, they are about 150 feet below the top of the mountain. This, probably, arises largely from the thinning down of the iron limestone in that direction.

This great bed of ore is here above the average of the bed in quality. Will average from 40 to 50 per cent. of iron.

*This has, since the above was written, been found to result from a great slide on the N. W. face of the mountain at that place, which carried some of the ore bed and underlying iron lime rock down into Sand Valley. They are not there in their normal position. The dip also increases to 20° , and even 30° on the face of the mountain.

It is of medium solidity, or hardness; hence will be easily mined and handled.

The third and fourth beds do not exist here. The space where they belong is yet taken up by the iron limestone. It is probable that the 5th bed begins about here, or a little higher up, but as the S. East side of the mountain now has more slope, its position is wholly obscured by talus. It is not seen till near the centre of Sect. 28.

THE GREAT IRON ORE BED NEAR VILLAGE SPRINGS.

In Sect. 28, T. 14, R. 1, W., the Red Mountain has been cut in two by a fault. Through the gap thus made a public road has run, since the country was settled. On the upper side of this road, and near the base of the mountain, is exposed probably the largest mass of red hematite ore that exists in the State. It is the 5th bed—the one lowest down in the Clinton. It is based directly on the Trenton limestone, which is here seen slightly cropping out in the wash at its base. Originally no iron ore was seen here; the talus from the mountain, and detritus from the gap beyond, had covered it over. Gradually, the wearing down of the public road exposed some iron bearing shales near the top of the bed. These were long considered of no prospective value. To carry off the surface water, a channel was cut on the side of the road. The water soon cut down to the ore, and made a deep channel through the bed. To this its discovery was due. The ore is generally soft, fine grained and dark colored. In shade it runs from a deep brown to dark grey and black. In texture and quality it is not uniform. Near the top and near the middle is a thick belt of rich, coarse grained ore. Beneath each of these are still broader belts of nearly black ore, fine grained and of inferior quality. The dip of the different parts of the bed is neither regular nor uniform. The dip in different parts varies from 10° to 28° . Generally near the base of the bed the ore was of lowest grade. The different parts as seen will vary from 35 to 50 per cent. of iron.

The exact thickness of this bed could not be calculated

from the dip and exposure. Its slant surface measures 83 feet from top to bottom, and assuming the average dip to be near 20° would make its thickness over 30 feet. This was the nearest approximation that could be made from the present data. But it is probable that a slide has occurred here, that the upper part of the bed at least has doubled on the lower part. If this has not taken place, the difference in dip in different parts of the bed, and the apparent duplication of certain strata of ore, must be left wholly without explanation.

This is a most valuable bed of ore, not only from its great bulk, but it carries some ore of superior grade to any heretofore found in this bed. Then its position near the base of the mountain makes it so accessible as to add greatly to its value. Its position here is a little below its normal place, probably caused by the fault referred to. Half a mile or more farther down the mountain it was seen at a somewhat higher level. There has been a slight downward flexure near the main exposure of the bed, but the amount of it is not great. This bed probably extends for a mile or more up the valley. The shape of the slope or bench above the top of the Trenton almost gives assurance of its extension that far. As has been heretofore observed, a bench in the Clinton, immediately above the Trenton, may be regarded as indicating the presence of this bed. Should this observation be fully verified, large and extensive bodies of ore will yet be found which are not thought of now, and the value of the Clinton formation will be much increased.

Opposite Village Springs, in the Southern part of Sect. 28, Village Creek cuts through the Red Mountain. The two ore beds, 1st and 5th, were seen cropping out at the end next the creek. Neither of them seemed to carry as much or as good ore as farther up the mountain. But their relative positions are of much Geological interest. They are now the *only beds in the Clinton*. The *top* and the *bottom* ones of the series. For the others there is now no place. They, and their associated strata, have either disappeared, or been absorbed in the body of the iron limestone. Will they re-ap-

pear and resume their former relations? This question cannot be fully answered here; they may do so farther down the valley, but in the bounds assigned to this report, they appear no more.

The iron limestone was seen below Village Creek, though it was inferred, from its thickness above the Creek, and its gradual taper, that it probably extends about a mile farther. Below the Creek the rocks are but little exposed, and the geological structure cannot be seen. This is to be regretted, for the manner in which the *upper* and *lower* iron ore beds *come together*, if indeed they do so, would be of very great interest to a geologist. From their relative position where last seen, they must either *come together at the end of the iron limestone*, or other strata must occupy *its* place.

COMPTON MINES.

Since these pages were written extensive mining has been, and is still done, at this place, by J. W. Worthington & Co.; both of iron ore in Red Mountain—and of Lime Rock quarried from the foot of Sand Mountain on the opposite side of Sand Valley. These extensive works are known by the name of COMPTON MINES. They are connected with the Mineral R. R. at the Village Springs by a branch road three miles long, crossing Village Creek, and passing through the gap it cuts in Red Mountain, into Sand Valley. Thence one branch of it runs up the foot of Red Mountain to the iron ore mines; the other crosses Sand Valley to the Lime Rock quarries.

As was foreseen the mode of mining iron ore here was by stripping from the top of the mountain downwards, as the most economical and expeditious. This mode was first adopted and the ore bed was laid bare along the top of the mountain for nearly half a mile. Ore was thus very rapidly and cheaply raised, and run down the mountain to the railroad by cable cars. It was soon found however that many faults and flexures from N. W. to S. E. crossed this mountain and very seriously interrupted the regularity of the ore bed. Also that the dip increased to the N. W. on the face of the mountain, and soon made stripping too deep to be done advantageously. Farther stripping was therefore abandoned,

and for the last two years regular mining, and tunneling has been pursued. Drifts are run along the face of the mountain so to as be self draining—and give a gentle descent to the loaded cars. Only the 1st, or upper bed of ore is worked here, or rather the 1st and 2nd beds combined; for they in fact are here united and practically make one bed, or seam. At the brow of the mountain their united thickness was from 4 to 6 feet. This thickness has gradually diminished with depth and increased pressure—and the lowest levels have now only $2\frac{1}{2}$ feet of ore.

Sixty miners are now employed here, and the daily output is 200 tons of ore.

The quality of the ore is practically the same from the top to the base of Red Mountain—only the seam is gradually diminishing in thickness from increased pressure. And a doubt is now seriously entertained that the iron bearing Clinton does not extend westward beneath Sand Valley. We must await further developments before modifying our views on this subject. On the west side of the town of *Compton*, at the base of Sand Mountain, are seven quarries worked by this company. The quarries are on a great ledge of Carboniferous Limestone, that is here very prominently exposed. About 200 hands are employed, and the daily output is 1,000 tons of lime rock, mainly used for flux by the Birmingham and Bessemer furnaces.

In addition to this, Col. Hatch operates another quarry further to the S. W., and near the line of Blount and Jefferson counties. He employs about 40 hands, and puts out about 200 tons of lime rock per day, which goes to the same markets.

The lime rock that is mainly quarried here is a ledge of solid rock 16 feet thick, of unusually pure carbonate of lime. This ledge yields by analysis from 95 to $98\frac{1}{2}$ *Carbonate of Lime*, and 1.70 to 2.20 of Silica, with only a small fraction of one per cent. of Carb. of Magnesia.

This rock is so perfectly adapted for fluxing and the best that can be obtained for this purpose, that the furnaces require and demand it, to the exclusion of all others. Hence,

much lime rock here that is really good, is thrown away; much of it that would do for flux, or make excellent lime, is wasted and thrown on the dump. The company pays the same price ($12\frac{1}{2}$ cents per tram load) for refuse, as for selected shipping rock. This falls very heavy on the profits of the company. Two-thirds, probably three-fourths, of the rock mined here is thrown on the dump as refuse.

The company does all the drilling, for quarrying and pop shots; supplies all the dynamite, or explosives that are needed in this work. The drilling is done by compressed air, delivered by pipes from a central station, where the air is compressed by a large stationary engine.

Compressed air is found to be much more desirable and comfortable in working than steam power; it dispels the dust and diffuses a cooling atmosphere around the drills, enabling the operatives to work in comfort under the exposure of intense sunshine and heat of this Southern climate.

Quarrymen here work by the *car load*, or piece work, not by the day. They work in the morning and in the afternoon, and on an average make about 12 tram car loads per day, netting them as wages about \$1.50 on an average.

The face of the bluff in all these quarries is now from 50 to 75 feet. It seems to be no longer practicable to quarry this amount of rock, and only ship 16 feet of it. Arrangements are, therefore, being now made to tunnel and mine out this *pure ledge alone*. An experimental drift is now being run into the bluff at one of the quarries, to test the feasibility of *mining* instead of quarrying this rock. If this project succeeds—if they can successfully mine *this ledge alone*, and put out an amount of rock equal to what is now done by quarrying—it will be a great saving in expense to the company. It will require fewer hands to operate the quarries and attain the same results, or product of the quarries; and while wages of operators will not be diminished, the profits of the company will be increased, and the importance of the quarries very largely augmented.

The town of COMPTON, built up solely by this mining and quarrying industry, is the largest town in Blount county.

It is regularly laid out, about a mile long and a quarter of a mile wide; and though not compactly built up, houses about 250 operatives and some 1,200 inhabitants.

It is a place continually busy with the noise and throb of industry, and daily sends out from 50 to 60 car loads of lime rock and iron ore.

We have now reached the lower end of Murphree's Valley, at its junction with Jones' (Opossum) Valley. A change in the direction, or strike of the Red Mountain takes place here. It now for several miles trends S. S. W. A change also occurs in the structure of its rocks, and their arrangement, and the position of its included iron ores. These changes probably begin above the Jefferson county line, and without a notice of them, this part of the report would not be complete.

The Trenton rocks do not come to the surface for several miles. The Clinton makes the mountain. It is therefore not so high as formerly, and shows Clinton strata alone on the S. E. side. The rocks become thin and rather shaly. The trend of the mountain brings it closer and closer to the great Murphree's Valley fault, and at Turkey creek they co-incide. The Clinton strata are here thrown vertical, and afford the first opportunity to see the structure since crossing Village creek. The effect of this fault has been to break up the Clinton into knobs and short ridges, with diversity of trend. In several of these for two miles N. N. E. of Turkey creek, good shows of iron ore have been exposed, but these were not sufficient to show the whole structure. At Turkey creek, however, on the Eastern side of S. 30, T. 15, R. 1, W., is as fine a natural section of the Clinton as could be desired.

The vertical uplift caused by the fault has here raised the Clinton in a *low vertical, crescent shaped ridge*. The curve is S. E. and South, and is cut by the creek at its most southerly point. A mill has been erected here by J. P. Blackburn, and the mill race was cut entirely through the vertical Clinton strata. All parts of it are therefore exposed, from near the Black Shale (which was not seen) to the top of the Trenton, which now makes its appearance in the creek

above. The Clinton rocks are very uniform in texture, and are all thin or shaly. Toward the base side, where they join the Trenton, they are harder and of a bluish color. In all other parts they are reddish brown. The race had not been cut at right angles with the strike, but quartering and meandering, hence measurements were not made. But the thickness of the strata exposed was estimated to be 200 feet. In this estimate the position of the Black Shale was assumed to be in a deep hole below the mill. But the most important and interesting thing here is the *iron ore*. It all lies in *two beds*, or rather in *one bed* with a parting of three feet. It is at about one-third the thickness of the Clinton from the top, and therefore occupies about the same position as the third bed in the upper part of the mountain. The upper part of it is *20 feet thick*, the lower part *9 feet thick*, with a rock and shaly parting of three feet between. Whole thickness of the bed *32 feet, with 29 feet of ore*. This may have been two beds formed here very close together, but as the ore is the same in each, both in quality and structure, it is thought proper to consider both parts as one bed. This ore is strictly first-class ore: It will average over 50 per cent. of metallic iron. The ore is partly lenticular or flattened grain, and partly round grain, closely compacted together; heavy and solid, but not hard. It is not identical with any of the beds hitherto described in Red Mountain; its ore is different from any of them, though nearly identical with some yet to be described in the S. E. side of the valley. What has become of all of the other Red Mountain beds? Why is it that only *one* mammoth bed exists here in the Clinton formation? Our knowledge of the geological structure is not yet sufficient to explain these apparent anomalies.

The exposures of the Clinton ores on the S. E. side of the valley.—The examination of the Red Hematite ores on the south-east side of this valley next demand attention.

Beginning at the head, or upper end of the valley, we find exposures of this ore in regular order, till we reach Green Wade's in S. 36, T. 12 of R. 3, east. From this point it does not appear again on the surface for fifteen miles

down the valley. It has been eroded away, and the ends of the Clinton formation covered over by Sub-Carboniferous Chert.

In Sec. 27, T. 12, R. 2, East, this formation comes again prominently to the surface, and the following section was obtained here:

Section of Clinton Strata.—S. 27, T. 12, R. 2, E.

Top bed. No. 1, round grained, rough ore..... 4 ft. 0 in.

Rock soft yellow 3 ft. 7 in.

2d Bed. No. 2, Fossiliferous ore..... 0 ft. 3 in.

3d Bed, not seen, rock and clay..... 15 ft. 0 in.

4th Bed, or No. 4, blue colored, soft ore 3 ft. 0 in.

Rock hard..... 1 ft. 6 in.

5th Bed (No. 5), soft, dark brown ore..... 4 ft. 0 in.

Total Clinton strata.....31 ft. 4 in.

And carrying 11 feet 3 inches of iron ore. From base of 5th bed to Black Shale was 50 feet only, while between the 4th and 5th bed was a bar of rock 18 inches thick. Below bed No. 5 the rocks were covered up, so that the position of the Clinton to the underlying strata could not be seen. This was probably near the fault line. Only silt and clay covered the surface along the base of the Clinton for some miles. This was the only place, for many miles, that the 5th bed was clearly seen. Nor was it seen, or supposed to exist, in the Red Mountain opposite to this place. But this need not excite surprise; the ore beds are *driven identical* on both sides of the valley, at right angles with the strike.

The Clinton ores on this side of the valley are all contained in the long strip of reversed strata heretofore described, cut off by a deep fault and sunk on the N. W. side. They hence dip to the N. W. at a high angle, usually 30° to 45°. Where these ores show close to the line of the fault, they extend under ground but a short distance, only till the fault is reached. In the adjoining section 34 a good show of ore existed a few years ago. A bed four feet thick stood up on the bank of a little stream. It was just at the fault, the stub end of a bed. During a freshet this was undermined

and swept away. That stub end was all of it. In very many places on this side of the valley, in the low places denudation has cut below and swept away all the beds. In the low grounds, if the beds cannot be seen, the probability is that they do not exist. As a rule, the high grounds only can be calculated on to yield much ore. Even they are sometimes deceptive, as occasionally they may be near the fault. An instance that occurred near this place will show this. A speculator, who was trying to sell again, sunk a pit on a good seam of ore four feet thick. To show that it maintained its thickness and quality, he wished to cut it again at the depth of 25 feet. He continued to dig, and at 14 feet from the surface came to the fault, where the iron stopped. These remarks are thrown in here, because this structure not being generally understood, many have built high hopes on iron prospects, which are visionary, and many have invested money in such property, on which they will never realize.

In the N. E. $\frac{1}{4}$ of section 33, same township, some small openings had been made, but not sufficiently deep to show the thickness of the beds, or to identify them. No good ore was seen in this section. A thin streak of Clinton strata, but carrying very inferior ore, runs along the S. E. edge of the brown ore in the S. E. $\frac{1}{4}$ of 33, and the N. W. of S. 4, T. 13, R. 2, E. It is again seen in the S. E. $\frac{1}{4}$ of Sec. 5, but unimportant both in quantity and quality. The space where it should exist has been deeply eroded by a stream of water, and probably the better portion of it has been swept away.

Through sections 12 and 13 of T. 13, R. 1, E., there is scarcely any sign of ore remaining. On a few higher points, only a little can yet be seen. The Sparry or Cambrian Limestone, which comes to the surface first in Sec. 5, T. 13, R. 2, E., is now a prominent member; and as the S. E. edge of it is on the line of the great fault, the presence or absence of the Clinton can be clearly told. If the next member adjoining this limestone is the Lower Siliceous, or the LaGrange, then it is certain the Clinton has been engulfed in the fault. If the space between these formations and the

limestone is sufficient to contain the Clinton, then we may be assured of its presence, though covered by debris of other formations. In the S. E. $\frac{1}{4}$ of Sect. 12, this limestone and the Lagrange sandstone come together; the Clinton and Lower Siliceous therefore *have both gone down in the fault*. In a portion of section 13 only a part of the Clinton has disappeared. A little farther S. W., in the same section, the Clinton comes up in a bold ridge, with Lower Siliceous Chert scattered over its surface. Several openings have been made here; ore generally shaly and poor. The top bed measured two feet; ore of fair quality. In these two sections 12 and 13 much labor has been lost in searching and digging for iron ore. Not because it does not exist, but because the labor was not expended in the proper places.

In the S. E. $\frac{1}{4}$ of S. 13 there is a notable example of the Clinton, after being for a space engulfed in the fault, again coming above the surface near the Chepultepec and Springville road. For a quarter of a mile the Clinton does not show, it is below the surface; then it rapidly rises into a ridge 70 feet high. Near the N. E. end of this ridge, in a pit, its strata were seen dipping N. E. 75° . In a short space farther to the S. W., or down the ridge, it resumed its usual N. W. dip. It was very evident, therefore, that the N. E. end of this ridge had been forced up, almost vertically at the end of the submerged portion. It makes a prominent ridge for over half mile. In the eastern part of section 23, most of the Clinton is again beneath the surface.

In the S. W. $\frac{1}{4}$ of N. E. $\frac{1}{4}$ of S. 23 T. 13 R. 1, E; on the lands of J. P. Box, the iron ore beds are again brought to the surface. A bed of hard, solid, rough ore, was here seen two feet thick, lying close to the Black Shale, with no visible intervening rocks. It is certainly the bed classed as No. 1 in the general section. The nonexistence of roofing rocks above it is a local peculiarity. On the same tract at a lower level, a bed of similar ore was seen, of about the same thickness. It is probably the same bed. The rocks were not exposed so as to decide definitely, and relative levels, afford no criterion for identifying ore beds on this side of the valley. The

strata are flexed upwards, and downwards, with very great irregularity. Some other small beds had been cut on this tract, but they were apparently unimportant. Slight indications of manganese were also seen on this tract, and the one south of it, in the same section. A small body of it probably exists here in the Lower Siliceous strata. Towards the western side of S. 23 the surface show of iron ore becomes much better—and extends into Section 22 (S. E. corner.) Several small holes had been dug on it, at several places. At an early period of the mineral excitement, one mile in length of the lode, (or "lead" as it is called,) was sold to a speculator for twenty-five dollars per acre, being a strip one mile long, by a quarter mile wide.

As this property was considered very valuable, and supposed to contain a great quantity of excellent ore, it received very careful attention. A branch, or little stream of water, has cut through the Clinton near the principal exposures of the ore, and laid bare its entire structure. A sharp backed ridge runs south on the S. W. side of the branch, and E. N. E. on the other. The strike of ore does not conform to the trend of these ridges; but crosses them at an acute angle. Ore is therefore shown on both sides of the E. N. E. ridge, and on the top of the other. The dip is different on the two sides of the branch. On the N. E. side it is N. W. 18° —on the other side N. W. 70° . Hence there is not only at this point a great change in the dip, but the trend also makes an obtuse angle. But these though peculiar features, do not complicate the structure. The Black Shale shows on both sides of the branch, and from it the Cambrian Limestone is 100 feet surface measure. The change in the dip rendered it impossible to calculate the vertical thickness of the Clinton here with accuracy, but it is between 40 and 60 feet. The best show of ore is at the side of the branch—thickness 30 inches—24 inches of this solid, and uniform—will yield about 40 per cent. of iron—the other six inches inferior. Higher up the ridge, the same bed had again been opened on the east side. The bed is here 20 feet from the Black Shale. It is hence the upper bed or No. 1—measured

here nearly 30 inches, ore rather soft, carrying perhaps 35 per cent. of iron—Bed No. 2 not here—A shaly stratum of irony matter about one foot thick, seen only on the N. E. side, evidently represents Bed No. 3; of no value. On the western side of this ridge bed No. 1 again crops out; ore about the same as at the branch not cut through, and thickness unknown.* The trend of this ore is evidently towards the fault in a S. W. direction and if it does not change after leaving the ridge, it cannot possibly run far in that direction. On the south side of the branch the rocks are naked from the ore bed almost to the fault. Only one bed of ore exists here—the same one seen on the other side. It here measured 17 inches—35 per cent. of iron.

Two hundred yards S. W. from this branch is a good exposure of the Black Shale, and the strata beneath it for twenty yards. But very little of these strata could be identified as Clinton. It was certainly the crumbled debris that filled up the fault, where the Clinton had sunk. No ore fragments even, could be found here, or in any part of the low ground. For half a mile to the S. W. the line of the fault is marked by a depression between the Cambrian Limestone and the Lower Siliceous. It is not believed that any iron ore or even Clinton strata will be found there. On a higher point which juts down into this depression, an opening had been made and some ore evidently of the upper bed, had been taken out. It was evidently not thick. In another pit dug on the same line but on lower ground it was not found. No further indication of the existence of iron ore, was found on this tract. It is therefore evident that nearly all of the available ore, contained in this greatly over-rated property, lies within a hundred yards, or less, of the branch which cuts through it. That the average thickness of its single bed is less than 2 feet of ore.

In the S. E. $\frac{1}{4}$ of S. 22 same Tp., the Clinton strata became still thinner, surface distance across it 50 feet, and in

*Since this was written several cuts have been made here—ore 1 foot thick, and much faulted.

the S. E. $\frac{1}{4}$ of the S. E. $\frac{1}{4}$ it sinks beneath the surface. The upper bed of iron ore was found on this tract, about the same thickness and quality as in Sec. 23.

At the point where the last of the Clinton passes beneath the surface, a new member, not heretofore seen in this valley, is largely exposed. It is the *Keokuk Limestone* of the Lower Siliceous formation. It is here, at once a heavy member, and though its geological relations cannot be seen here, yet it continues into section 27, where its relations are clearly seen. This member might, from its appearance, be very readily mistaken for the Carboniferous or Mountain Limestone—and if seen only at this point, would be so regarded, even by sharp-eyed geologists. But when traced farther its position is seen to be beneath the LaGrange or Oxmoor Sandstone, and just above the Black Shale, and hence a member of the Lower Siliceous group—its lowest member. It is here a very pure semi-Crystalline limestone—about 100 feet thick.

On entering Sect. 27 in the N. $\frac{1}{4}$ of the N. E. $\frac{1}{4}$ we pass directly from the top of the Keokuk Limestone on to the top of the Clinton—the former having been lapped over on the latter, for the last half mile. The Clinton is here in a high narrow ridge. Some iron ore of good quality is seen in it, belonging to the 1st and 2nd beds, but the quantity is inconsiderable. The ridge has the appearance of being principally made up of Clinton strata, and the distance from the 1st ore bed to the first Cambrian Limestone, is over 200 feet. This with a dip of 45° would give it a thickness of over 100 feet. But no other beds, or fragments from them, could be found. It is probable that the Limestone comes much closer here than it appears to do, and that it is covered over by debris from the Clinton. This is seen to be the case 200 yards to the S. W. The Clinton here becomes very narrow—not more than 50 feet thick, and in the S. W. $\frac{1}{4}$ of the N. E. $\frac{1}{4}$ it is yet much thinner. A stream cuts through it (the Wade Gap stream) near this, or in this tract. The rocks are exposed, and gave the following section, as measured at right angles with the strike:

Section in S. 27, T. 13, R. 1 E.

Black Shale Dip 45 N. W.

Hard seamy sand rock.....	15 ft.
Shale and soft rock.....	11 "
Iron ore No. 1.....	8 in.
" 2.....	2 "
Shale.	
" 3.....	3 to 4 "
Shale.	
" 4.....	4 "
Shale.	
Shale and debris.	
Whole thickness of iron ore. 18 in. —	
Total thickness of Clinton.....	33 ft.

It seems that the Clinton diminishes in thickness in proportion to depth, and proximity to the fault, at least, at this place. Through the remainder of this section, no ore beds, or any evidence of their existence, were found. They seemed to have been entirely swept away.

In the E. $\frac{1}{2}$ of the S. E. $\frac{1}{4}$ of Sect. 28, same Tp., a good show of ore is presented on several high points. It was principally from bed No. 1—ore of average quality. The pits which had been dug on it, were filled up, and its thickness was not seen. The existence of bed No. 3 was also shown by the outcrop, but it had not been opened. From appearances the top bed was supposed to be 2 to 3 feet thick, the other, less probably than two.

Through the N. W. of the S. E. of Sect. 28 there is evidence of the existence of iron on the high points—though very little of it was seen. Through the remainder of this Section the Lower Siliceous joins the Cambrian Limestone, sometimes lapping over on it. Occasionally the LaGrange Sandstone is seen close to the limestone. In all such places the Clinton has gone down in the fault. This arrangement continues to the Township line, and in a greater, or less degree, to the middle of Sect. 6, T. 14, R. 1 E. Through the space thus passed over, though some ore has been found,

yet the beds are not continuous, and are so deranged by the irregularity of the strata, as to be of uncertain value.

From Sect. 6, T. 14, R. 1 E., to Sect. 5, T. 13, R. 2 E., a distance of nine miles, the fault which cuts off the Clinton in its N. W. side, is evidently deeper than in any other part of the valley. The Clinton is often split off and divided, or entirely sunk, and seldom rises so high as not to have its lower parts denuded away. Hence the many breaks, and gaps, and irregularities observed in that portion of the valley. This irregularity does not entirely cease till the middle of S. 7, T. 14, R. 1 E. is reached.

In S. E. corner of S. 6, T. 14, R. 1 E. a small ridge of Clinton strata, which only runs a short distance, makes a very good show of ore. In about 100 yards this is covered over with the talus of the newer strata. Probably it again sinks, as otherwise it might be again seen a quarter of a mile farther on. For the space of the next quarter or half mile it cannot be known, with our present means, whether or no, the Clinton is above the level of the valley, as the whole surface is deeply covered by detritus of the Coal Measures, brought down by a small stream which cuts the Straight Mountain opposite this place.

In S. 7, T. 14, R. 1 E., begins a prominent ridge of Clinton, which continues with slight gaps to Sect. 13 of T. 14, R. 1 W. This is a high ridge, and contains a very fine body of Red Hematite ores. In the N. E. of the S. W., on the lands of Mr. Hullett, the best view of the whole structure was obtained. A little stream had here cut through the Clinton ridge, exposing in part of its course, the naked rocks, and one ore bed. Several pits had also been dug, and three beds were well exposed. The two upper beds had not been searched for; and they were not observed in the bed of the stream, being probably covered by loose rocks. Their existence here is certain; many samples, especially of No. 1, were found on top of the ridge—and its position was there plainly shown on the surface. A few samples of No. 2 were also picked up, but the bed here is evidently not prominent. At this place the Cambrian Limestone so far as could be

seen, did not approach close to the base of the Clinton ridge. Some limestones, which did not possess its characteristics, were seen near this place, lying between it and the Clinton. They were assumed to be Trenton limestone. If this is correct, then the depth of the Clinton, before reaching the fault, is greater here than in any other part of the valley. And its ores here will reach far below the water level, while in many parts that have already been described they scarcely reach to it.

A section through the Clinton, shows at the Hullett gap, the following measurements:

From Black Shale to base of 5th ore bed, 175 feet—surface measure.

1st and 2nd beds not seen.

3d bed solid, first-class ore..... 9 feet.

Rock, and earthy material..... 50 “

4th bed, limy ore, dark crystallized..... 5 “

Shale, and probably rock 15 “

5th bed, soft, fine grained, dark ore..... 14 “

Lime-rock.

Some doubts naturally arise on the classification of the ore beds at this place. That they stand, as here shown, is self-evident. But if the one marked 3d be *really the 3d bed*, it carries here an ore *very widely different* from what it does elsewhere. The ores of the 4th bed are also different from what it *usually* carries, and partake of the character of the fifth bed. Yet we must accept their position, and anomalies here, or *assume*, that the 3d bed has disappeared and that the 5th bed has been divided and the two parts separated by 15 feet of strata. This would tend to harmonize the contents of the beds here, with what obtains elsewhere. But we have as yet, no facts to support this assumption. And hypotheses, or assumptions, unsustained by facts, do not pass current in geological investigations. These doubts must therefore hold till farther development places additional facts within our reach.

The ore of the bed marked 3d is mainly lenticular with occasional round grains, dark brown to blue steely grey—

solid yet pulverent—judged to carry 12 to 14 per cent. of Silica, and about 50 per cent. of metallic iron. Its association here, with the 4th bed of good limy ore, is probably of considerable economic interest. The 4th bed will furnish lime enough to flux itself, and most of the 3d bed also.

This is the first time the 5th bed has been seen in any appreciable quantity for twelve miles. Its ore is such as it usually carries, rather soft where opened, but will probably be harder when better roofed in.

The height of the ore ridge is from 125 to 150 feet. All the way up its face large quantities of ore are exposed on the surface, mainly from the 3d bed. Near the top of the ridge this bed seems to be much thicker than at the base, this may be only apparently so—yet such a thickening upwards has been seen in many places heretofore. Along the top of this ridge samples from the 1st bed with their characteristic fossils were not uncommon. It had not been opened, and its existence had been overlooked. A little farther, say from a quarter to a half mile N. E., at the base of the ridge, an opening had been sunk down to the 4th bed, its thickness here could not be seen, and it showed no special features.

S. W. from the Hullett gap in the same $\frac{1}{4}$ Sect. was found another little gap on the lands of E. J. Cozby that exposed part of the structure. The 3d bed here measured 10 feet, but with iron clay parting 3 feet thick in the middle. A large portion of the space between the 3d and 4th beds is here filled with iron limestone. It could not be accurately measured, but is about 50 feet thick—then sandstone 4 feet. Then iron limestone of better quality than the upper ledge 22 feet. Beneath this, a partly exposed bed of soft, dark iron ore—the 5th bed; thickness unknown.

It is wonderful that in the short space of quarter of a mile the limy 4th bed, 5 feet thick, should expand and loose itself in such a mass of iron limestone.

Through the remainder of Sect. 7, iron ore shows profusely on the surface, and in all the little hollows in this ridge. The third bed is generally prominent. But iron ore

has been cut at so many places, and at different levels, that it seems probable splitting of some of the beds has occurred. The Clinton ridge becomes gradually lower toward the S. W. side of Section 7, but continues to carry large amounts of iron ores. There is probably more iron ore in the mile and a half just passed over than in any equal length of the Clinton on this side of the valley.

South-west of the 1st principal meridian line, in S. 13, T. 14, R. 1 W., the Clinton ridge sinks still lower until its top is almost on a level with the floor of the valley, and so continues mainly into S. 24. Very little ore is found along this sunken portion; yet it may exist beneath the water level. In the corner of S. 24 a bed of iron ore was seen—nearly 3 feet thick, but rather inferior in quality. It occurs in large coarse blocks, like carbonate ore, and its position in the Clinton was not apparent.

On the lands of Green Posey in S. 24, T. 14, R. 1 W., is found a large deposit, or ledge of the Lower Siliceous, or Keokuk Limestone. It is probably as large and thick as the one at the Wade Gap in S. 27, T. 13, R. 1 E., but not generally of as good quality, though it contains much very pure lime rock. In the face of this limestone bluff a deep cave extends rapidly downwards. It evidently carries off the waters of the branch which sinks near its mouth—it may be an extensive one, but is not known to have been explored.

South and East of this cave and limestone bluff, and from fifty to one hundred yards distant, the Lagrange or Oxmoor, Sandstone makes a prominent ridge, with rocks standing almost vertical, and some of them of imposing height. This place is about half a mile South of Remlap Station on the Birmingham Mineral R. R.

From near Remlap to Mt. Pinson, or Turkey Creek, the Sparry or Cambrian Limestone is not exposed. The Lower Silurian Chert adjoins, and often laps over on the Clinton. In this portion of the valley the depth of the break, and the amount of displacement of strata by the great fault is lessened by 500 to 1000 feet.

South-west from Remlap about a mile, in S. 23, T. 14, R.

1 W., on the lands of Reuben Little, the Clinton Ridge is abruptly thrust up again to the height of 150 feet, for a distance of half a mile. About $\frac{3}{4}$ of its length on the N. E. end is wholly composed of Lower Siliceous Chert. The other end wholly of Clinton Strata, carrying a large amount of good iron ore. An opening into a seam of ore on the top of the ridge showed a N. E. dip of 80° . At other openings the dips were different, and much less, some slightly to S. E., others to the N. W., while the *strike* of the seams is across the ridge, or from S. E. to N. W. The S. W. end of the ridge slopes gently down to the level of the valley, and apparently below the level of the Clinton.

The structure of this solitary ridge is very peculiar, and unique. An explanation of *why* it presents those features, or an attempt to trace out the dynamic forces that produced this structure, will not in our present state of knowledge be attempted. Our mission now is to trace, and point out the locations of the industrial materials of economic value, and their development.

A large amount of good iron ore exists in this little solitary ridge, and in position that is available for easy mining, and transportation. On the S. E. side of the ridge a long trench had been cut from the base of the ridge upwards, which showed the following section :

Section in S. 23, T. 14, R. 1 W.

Red hematite ore.....	3 feet.
Thin shaly sand rock.....	3 "
Red hematite ore.....	17 "
From the base upwards.	

This ore was all of the same quality and structure, and evidently one bed 23 feet thick, with rocky parting three feet from the bottom, giving 20 feet of ore.

The ore of this bed is of similar structure and quality to the bed at Hullett's Gap, classed as No. 3, in Sect. 7, of T. 14, 1 E. Differing from that only in being of more uniform brown color, and having a greater number of round grains,

varying from the size of small peas to sorghum seed, imbedded in it. This ore is above the average in grade. It resembles the great bed at Turkey Creek, but is not quite equal in quality. The natural drainage here is perfect, and the advantages for mining are all that could be desired.

On the slope of this ridge to the S. W. this bed has been removed. Its out crop is very plainly seen on the N. W. side of the ridge, but it had not been opened on that side. Several prospect holes had been sunk to strike this ore at other places, but for want of knowledge of the changes of dip they were improperly located. In one of these another bed was struck, which may be the 4th bed. It was too much filled up to get its dimensions, or judge fairly of its quality. Lower down and near the foot of the slope, at the S. W. end, ore had been found in several places of the same quality as the big bed above. They were probably slides, but so abraded as to hide their relations. Between them and the big bed was the evident out crop, of what was regarded as the 4th bed. Two hundred yards, or about that distance, from this out crop, S. S. W. on the N. W. $\frac{1}{4}$ of N. E. $\frac{1}{4}$ of S. 26, at a lower level, an extensive pit had been dug, uncovering the 5th bed. No ore was seen, as the dirt had partly filled up the pit. But the information obtained from the citizens, who had seen the pit dug and the ore measured, was that "the pit was sunk to the ore and it was uncovered to nearly the whole length of the pit; that it measured across the bed 22 feet." The ore was represented as soft, fine grained, and very dark colored. These are the general descriptive points of the 5th bed. There was nothing shown here by which the dip could be ascertained, and hence the actual thickness of this bed here could not be determined. No iron limestone seen here.

A little farther S. W. on the same tract of land in a ridge flanked by Lagrange or Oxmoor Sandstone on the South, some good pieces of manganese ore were found, and a larger show of manganiiferous limonite ore. Probably both exist here in sufficient quantity to be of value. The indications are sufficient to encourage the labor of testing.

Just below the body of iron ores last described, the Clinton sinks again beneath the surface. For a mile it is entirely engulfed, and the greater part, sometimes all, of the Lower Siliceous also. The LaGrange and the lower members of the Silurian (Knox) Chert join together at the fault.

Opposite this sunken portion of the Clinton, in S. 26, the LaGrange or Oxmoor Sandstone is a very massive, vertical ledge, through which flows that branch of Village Creek which rises in Spradling's Cove, or "Wild Cat Cove" as it is often called. The region up this branch presents some very notable features. On the left or eastern side is a large exposure of Carboniferous or Mountain Limestone, flanking the south western end of Raccoon Mountain Coal Field. A vertical thickness of about 200 feet of the limestone is shown here, and much of it of very good quality. Its base covered by talus is nowhere seen from the edge of Murphree's Valley to Wild Cat Cove. While on the opposite or western side of the branch at the same level is found only Lower Siliceous rocks and LaGrange Sandstones. And a half mile farther west the LaGrange is at a higher level than the opposite limestone. A very considerable difference of level produced either by fault or flexure exists here. On entering the Cove still greater complications of strata are seen. The floor of the Cove is of Carboniferous Limestone, and Lower Siliceous Chert; its western margin of LaGrange Sandstone, its eastern and southeastern side is Trenton Limestone and Clinton Strata, both vertical at the edge of the Cove and also showing much difference in level at different points. On the lands of George Chamblee in S. 11, T. 15, R. 1 W., on a seam of iron ore, the difference of level is over 100 feet in a space of 125 yards. The identity of the seam as seen at both places could not be mistaken. Both places showed about the same thickness, the same ore, the same underlying rocks. On the east side, where it was dipping very gently to the northwest, the bed was well exposed, showing upwards of four feet of soft, fine-grained, dark colored ore, a little better in quality than the general average of this bed. There is no question of its identity. This is the 5th bed, and

although only a little over 4 feet of ore was shown, yet it also carries a considerable thickness of pulverent, irony matter, which probably will be solid ore farther in. Above it, though not in close contact, was a good thickness of irony limestone, and above that another bed of iron ore about 3 feet thick of average quality. These were the only beds found in this section. But they were found in nearly all the numerous exposures of Clinton, which this Cove, and Clayton's Cove, farther to the South, present.

The region of these Coves is crossed by many faults trending in different directions. They are too numerous to admit of clear description. Two of these are prominent between Clayton's Cove, and Spradling's Cove. Their trend is N. E. and S. W. The N. W. side of each is heaved more than the whole thickness of the Clinton. It hence faces the S. E. and dips N. W. till the next fault is reached. It again is thrown up above the surface with a N. W. dip. Thus a double exposure of the Clinton is given in that portion, and a great amount of iron ore is rendered available. This N. W. dip terminates at the vertical Trenton and Clinton strata, heretofore noted at the S. E. edge of Spradling's Cove. A fault trending nearly N. and S. for a short distance, exists here, with several hundred feet of displacement of strata. Between this fault and the great Murphree's Valley fault, the dip is southeast. Spradling's Cove is an *area of depression*, the meeting line of the N. W. and S. E. slope, and yet it is floored with sub-Carboniferous strata, while Silurian strata rises high above it on both sides.

It may be here remarked that the whole region, embracing Spradling's, and Clayton's Coves, and their out lying ridges—in the fork, or biturcation of the great Birmingham and Cahaba valley, is a region of *much faulting, and diverse displacement*. Yet the stratum brought prominently to the surface by these faults, and displacements, is the iron bearing Clinton. And that in consequence of these faults a vastly greater breadth of ore, can be reached, and a much greater number of productive mines can be operated, than if these faults had not existed. This region is destined to be a rich

mining region; a busy field of productive enterprise. Only transportation is wanting to make its mineral treasures available now.

We resume the description of the Murphree's Valley ores at the point where the head waters of Village (Gurley's) Creek break through the vertical wall of LaGrange Sandstone, in S. 26, T. 14 of R. 1 west. This appears to be at, or near the south west end of this peculiar structure—this minor fold. It terminates opposite the termination of the Blount Mountain Coal Field. From this point south-westward for several miles this valley is a single fold—a simple anticlinal with the great fault at its apex, and the strata dipping from it, to the S. E. and N. W. The fault is now a little closer to the S. E. edge, or side of the valley, than heretofore, and its position is often obscured by the drift and talus from the mountain. The Lower Silurian (Knox) Chert on one side, and the Lower Siliceous (Sub-Carboniferous) on the other give a close approximation to the dividing fault line. No Clinton seen along the line till the N. E. $\frac{1}{4}$ of S. 34 of this Tp. is reached. About a half mile east of Village Springs, on the top of a high sharp ridge, the upper members of the Clinton again come to the surface. The well known 2nd seam of fossiliferous, or Encrinital ore is here standing above the surface. On top of the ridge it is almost vertical, and gradually changing to a steep S. E. dip farther to the south-west. There is here not only a steep S. E. dip, but also a rapid declination of the ore bed to the south-west. On the descent the First, or top seam of the Clinton, becomes also exposed. These two seams are close together, though not united as they are at the Worthington Mines in S's 22 and 28 on the opposite side of the valley. And with the further difference that the 2nd bed here is much thicker, and is first class ore, carrying 55 or 6 per cent of metallic iron, while the first or top bed is probably a little inferior. But as no openings have been made here, a reliable opinion of quantity or quality could not be entertained.

East Red Mountain begins at the gap where the Village Springs and Spralding's Cove road crosses the mountain, or

rim of the valley. South-west from that, the Clinton is found capping the mountain, and the Trenton Limestone making its base. The mountain is thence regular in its structure, and in all respects similar to the western or main Red Mountain of Murphree's Valley. From Village Springs its trend is S. S. W. to S. thus very materially increasing the width of the valley below that place. For a few miles it is a well defined ridge, or mountain, but becomes broken up into knobs, and detached fragments, and disappears in the bifurcation of the valley—in that broken up region heretofore referred to, lying between the north-eastern, and south-eastern prolongations of Jones' valley. The Red Mountain, or Clinton ridge *terminates*, but the whole region lying between the forks of the valley, and the terminal end of Raccoon or Blount Mountain, *is its equivalent*, and is mainly composed of Clinton and Sub-Carboniferous strata, much disrupted, but possessing admirable economic relations. It holds the same iron ore beds, carrying about the same *quantity* and *quality* of ore that we have previously seen in this formation.

In this region are also exposed large quantities of the flux rock, the Carboniferous or Mountain Limestone. It is presented in large volume, in, and north of Spradling's Cove; north east of Clayton's Cove, and east of Clayton's Cove, in Bear Mountain, which is almost wholly composed of Carboniferous Lime rock, and has also much *Calcite*, or pure Carbonate of lime.

We close our description of the east Red Mountain, with one sample of its ores as characteristic of the whole—taken in S. 3, T. 15, R. 1, W. on the main mountain separating Spradling's Cove from Jones' Valley.

An opening had been made here near the top of the mountain, on its western side, by John Rickles, who had long been a trusted agent of the Sloss Furnace Company. The opening was cut squarely in, on bed No. 1 of the General Section, and showed nearly three feet of good ore, about average quality for that seam. Dip 40° to S. E., crossing over the top of the mountain to the S. E. The slope of the mountain was found to be about 50° to the perpendicular. This slope

being greater than the dip of the strata, soon brought the ore bed No. 1 to the surface on the S. E. slope of the mountain, where it was exposed in the gullies and washes on its sides. It is near the surface all along the S. E. face of the mountain, and could be easily mined by stripping and surface working. The quality of the ore here is good, carrying about 50 per cent. of metallic iron.

The underlying beds were not fully exposed at this place. Openings had not been made on them, but the surface showings very clearly indicated their presence.

ESTIMATES.

We have now passed over the bounds allotted to this examination, and noted in detail all the prominent exposures of Red Hematite ore which it contains. These detailed descriptions aimed at strict accuracy, so far as they went. Yet they necessarily fail to give, even if they could be all enumerated, a clear and comprehensive idea of the total amount of ore contained in the region described. In attempting to show the quantity of ore, general terms had to be used. Quantities were said to be *great, very great, vast, inexhaustible*, etc. These terms are always indefinite, and many convey different meanings to different minds. To make the quantity of ore described clearly comprehensible by all, measurements made at various places must be aggregated, and computations made of the gross amount.

Beginning then where description ended, in the upper part of Jones' Valley, say at Turkey Creek, there are there 29 feet of ore, the same at Village Springs, and probably for a good distance above, and making on that side for 10 miles an average thickness of say 15 feet. On the other side it varies in the same distance from 7 to 30 feet, and taking in the gaps will give an average for the 10 miles of at least 5 feet, making total aggregate thickness of both 20 feet. This may be considered as equivalent to a body of ore 10 miles long and 20 feet thick. Much of this ore can be advantageously mined up the slope of the mountain for half a mile, but assuming a quarter of a mile to be the average extent of

profitable mining. Each mile contains 5,162,666 cubic yards of smelting ore, and the 10 miles 51,626,660 cubic yards.

The specific gravity of this ore is from 3 to 4, usually 3.8-10. Estimated at 3, it weighs over $2\frac{1}{2}$ tons to the cubic yard, or 12,906,665 tons per mile. Each mile would supply a 100 ton furnace, in constant blast, with 200 tons per day for 176 years. And assuming the net product of iron to be 45 per cent., would yield over 5,800,000 tons of iron, which at present prices would represent a gross valuation of over \$116,000,000, or for the 10 miles from Turkey creek to the Blackburn Fork of the Warrior, a total gross value of \$1,160,000,000.

To avoid any appearance of exaggeration in this calculation, the Cove ores were omitted, the beds assumed to exist *only* where already seen, the mining area put below the actual, and the specific gravity of the ores taken over one-fifth too low. These it was thought would more than counterbalance the amount necessarily left, and wasted in mining.

For the next 20 miles the ore is more uniform, though of less aggregate thickness, in the Red Mountain. But it is higher, and the extent of slope up which it may be mined is increased. In this portion it may be reckoned at 600 yards, or 1,036,800 square yards per mile. The beds show an aggregate of 5 to 11 feet. Assuming them only to average 5, and that the iron ore on the S. E. side would only add 1 foot to this, or a total for both sides of 6 feet, and that the specific gravity is, as before, taken at 3. Then this area contains 42,240,000 cubic yards of ore, weighing over 105,600,000 tons. Sufficient to run 10 hundred-ton furnaces, or one every two miles, for 145 years.

The next ten miles have not yet been sufficiently opened up to be estimated, but they will add something to the general aggregate, if they only add an amount equivalent to two miles of the preceding area, or 10,560,000 tons. Then this valley holds by estimate over 245,226,650 tons of Red Hematite ore, with a spot cash value, at 15 cents per ton royalty, of over \$21,000,000.

The amounts are beyond the grasp of the ordinary mind,

but they are more tangible than the general descriptive terms *vast, unlimited, incalculable*, and the like so often employed.

The brown ores will be next considered.

BROWN IRON ORES—LIMONITES.

There are six (6) different horizons in this valley that carry *Brown Iron Ore*, or Limonite Ore, as it is more properly called. These, beginning with the lowest, and most important are:

1. The base of the Knox Dolomite, or base of Lower Silurian.
2. A little below the middle of the lower half of the Knox Dolomite, or 400 to 500 ft. above its base.
3. Near the top of the Knox Dolomite, but below the "Birmingham Breccia," where it exists.
4. In the base, or lowest member of the Trenton.
5. Near the top of the Siliceous Group, and beneath the LaGrange, or Oxmoor Sandstone.
6. The top of the Sub-Carboniferous, or Mountain Limestone.

The ore is not stratified, or generally continuous for any great distance. It exists mainly as deposits, and these often widely separated. But wherever found in large or small quantities, in this or any of the other Silurian Valleys of Alabama, it is in one or other of these six horizons, and never scattered through any intermediate formation. Hence bearing this important fact in mind, the hidden deposits of this ore may be as systematically searched for and found as the beds of the Red Hematite ores.

When it is remembered that all, or nearly all, of the brown ores that are known have been exposed by natural agencies alone, it can hardly be doubted that many more yet exist unknown, but which may be revealed by properly directed search and effort.

For the purpose of showing where the brown ores may

be searched for with hopes of success, a more detailed description of the several horizons is given.

The First or Lowest Limonite Horizon—Is the top of the Upper Cambrian or base of the Lower Silurian. The top members of the Cambrian are usually heavy bedded, massive, siliceous lime rocks. Sometimes in this valley these are covered by a thin member of coarse, rusty colored sand-rocks. Above this, in the Lower Silurian, but conformable to the underlying Cambrian, is the Lower Limonite horizon. No iron ore is found beneath this in our Silurian valleys. While the oldest member of the Knox Dolomite, or Lower Silurian is iron-bearing, the iron occurs in available quantities only in certain localities.

This ore is usually associated with, and imbedded in, large quantities of iron clay, or dark red ochre. Hence its presence in some quantity may be anticipated, wherever there is much of the latter, even though there is little or none of the ore exposed on the surface. The exposure of the base of the Silurian is along only a narrow belt in this valley, hence many exposures of this deep lying ore could not be reasonably expected. One of these, and the most prominent, is on the Township line between Tps. 12 and 13 of R. 2 East, and known as the *Champion Mines*. A detailed description of these will be given hereafter. From Champion Mines the ore may be traced along the base of the Silurian towards the S. W. to S. 22, T. 13 of R. 1 E., where strong indications are found of the existence of an ore deposit, though it does not show on the surface.

In S. 34, T. 14 of R. 1 W., near Village Springs, a body of brown ore is found, but as the Cambrian rocks do not there come to the surface, it is uncertain whether it belongs to this horizon, or the next one above. Also a deposit near Palmer's Station is left unclassified for the same reason.

At Mt. Pinson the Cambrian rocks are again exposed, and this iron bearing horizon is also largely exposed for several miles to the S. W., and gives fine indications of holding bodies of iron ore. Good ore has been seen on the

hills around here at the corresponding level, and shot ore is seen in the gullies on the red hill sides. Hence the expectation that bodies, or deposits of ore may be found in this region, may be reasonably indulged.

The Second Limonite Horizon—Is also in the *Lower Silurian* or Knox Dolomite formation, about 400 to 500 feet above its base. The intervening space between these horizons is mainly destitute of iron.

This horizon makes its appearance much farther to the northeast in this valley than the former one. At the higher level where this portion of the Silurian first comes to the surface, in S. 18, T. 12 of R. 3 E., is a good exposure of it. Much ore is here scattered over about 40 acres of surface. Some of it very good ore, equal to the best. Some very impure, heavily mixed with chert, yet showing an amount of available ore of fair quality to invite development. It may be, probably is, much more extensive than is shown by the surface ore. The gentle slope of the hills here make it almost certain that the ore body, 50 to 75 feet thick, may carry available quantities of ore much farther than it is seen on the surface.

This belt, or horizon of ore, next makes its appearance on the Foster and Robinett places, in S. 13 or 14, T. 12, R. 2 E., and extends thence to the Byrd place in S. 22, T. 12, R. 2 E., nearly South of Hood's Cross roads. It here attains its greatest volume, or thickness. Certainly one hundred to one hundred and fifty feet. Much ore is shown on the surface, and the quality is almost equal to the first horizon at *Champion Mines*. But the ore is more scattered through a great mass of iron clay and ochre. The hills, almost wholly composed of this material, rise to the height of 100 to 200 feet above the valley. That much valuable ore exists here, is very evident, but whether the proportion of ore to the surplus mass of waste material is sufficient to make mining profitable, remains yet to be demonstrated. From this point towards the S. W. this belt of iron bearing strata diminishes in volume. It shows itself again in S. 31,

T. 12 of R. 2 E., in several ridges of ferruginous material, but carrying only occasional chunks of Limonite ore of no economic value. From thence south-westwards it is only an irony belt of chert rock.

The Third Limonite Horizon—Shows itself first still farther to the N. E. than either of the preceeding horizons. Its first prominent exposure is on the lands of Eli Bynum in S. 7, T. 11, R. 3, east. It is there an iron bearing stratum, probably 40 or 50 feet thick, and carrying small chunks of good limonite ore. The quantity apparently insufficient for profitable mining. From there it can be easily traced south-westward for a long distance. Its exact position in the Silurian Chert formation is not so easily defined as the preceding horizons. There are no prominent rocks or ledges here to mark its position. The nearest approximation to its position is from 100 to 150 feet below the lower Conglomerate, or "Birmingham Breccia."

It is less prominent, but *more persistent* than either of the preceding horizons. It may easily be traced for the greater length of this valley. In some places it carries limonite ore, in others *red hematite*. In some places both *limonite and hematite are found together*, while in many others there is no ore, and only a thick belt of irony rocks marks its position. Usually in the upper part of this valley both the limonite and hematite deposits and beds are thin, and may not carry ore enough to be of economic value. But I am informed by a note from Dr. E. A. Smith, State Geologist, that in the lower part of the valley a bed four feet thick in one place of red hematite ore has been found in the Lower Silurian at Pratt's Ferry in Bibb county, and has been traced to Birmingham. It belongs either to this horizon or the next above it, the base of the Trenton. No others carry red hematite ores, so far as yet observed.

The Fourth Limonite Horizon is in this valley unimportant, as it carries but little ore. It is the base of the Trenton formation, or rather the magnesian limestone, which often

makes the base of the Trenton. At a few places along this line, limonite ore has been found; and in at least one place in S. 20, T. 13, R. 1, E., in such quantities as to leave no doubt of its being a belt or horizon of limonite ore. The ore bed here, though not very extensive, is peculiar in carrying a mixture of *limonite and turgite* combined. Also in S. 28, T. 14, R. 1, W., near Village Springs, good limonite was found, which could only be referred to this horizon.

The Fifth Limonite Horizon is more important. It is the upper part of the Siliceous Group of the Sub-Carboniferous. The belt carrying ore does not seem to be continuous here, but in a few places it carries large amounts of good brown ore. One of these places is in S. 16, T. 12, R. 2, E. Ore of very fine quality exists here, and in quantity sufficient to establish this as a brown ore bearing horizon. It was seen at many places along Sand valley, at or near the base of the LaGrange Sandstone; but the most prominent deposit of it occurs on the S. E. side of the valley in S. 5, T. 13, R. 2, E. It exists here in great volume between the Sub-Carboniferous Chert and the LaGrange Sandstone. Some of it is very cherty and impure, but much of it, especially the lower portion of the ledge, is excellent ore. Its surroundings here clearly show that this is Sub-Carboniferous ore, though, by faulting, it is thrown in close proximity to the Silurian ore of horizon No. 1. It is also seen at the base of the iron ridge in S. 33, T. 12, R. 2, E., associated with the same Sub-Carboniferous rocks, and showing the same characteristics.

The Sixth Limonite Horizon is the top of Carboniferous or Mountain Limestone, or the base of the Sub-Conglomerate Coal Measures.

Almost continuously along this line is found a belt of brown ore, though seldom in quantity sufficient to be of practicable value.

The iron ore in this horizon is often good limonite, but generally sandy; and in many places replaced by carbonate or spathic ore, some places in considerable volume. This

horizon is so well defined and easily recognized that further description is unnecessary.

DETAILS.

. In the further descriptions of the brown ores of this valley they will be referred to their proper horizons, in connection with the locations in which they are found, and in consecutive order from the head of the valley to its S. W. end.

That portion of the valley lying N. E. of the Locust Fork of the Warrior river, called *Bristow's Cove*, exposes no brown ores on the surface. They very probably exist there as in other parts of the valley, but the uplift there has not been sufficiently great to bring the main brown ore bearing horizons to the surface.

Only on the west side of the cove, at the foot of Sand Mountain on lands formerly belonging to Levi Murphree, deceased, there is a large show of spathic iron. It belongs to the 6th Limonite horizon. If the 5th horizon carries brown ore here, it is covered up by the drift and silt of Sand valley, and does not show on the surface. The oldest rocks exposed in the Cove is the top of the Trenton, hence the great brown ore bearing strata can not be seen.

On the S. W. side of the river, about one mile south of where it cuts the rim of the valley, in S. 9, T. 11, R. 3, E., on the face of Sand Mountain, there is a good show of good brown ore. It belongs to the upper or 6th horizon. The quantity, as shown scattered along the face of the mountain, and its quality exceeds what is usually found in this horizon.

In S. 15, T. 12, R. 3, E., on the lands of Wiley Bynum, is a deposit of brown ore of considerable extent, but uncertain thickness. It is generally very good ore, imbedded in rich red ochre; bed not cut through, or any exposure made that would show its thickness, or give any approximate knowledge of the quantity of the ore. So far as cut into, it showed chunks of small size, smooth and regular, and shot ore with but little admixture of chert or rock. This deposit belongs to the third horizon.

A little farther to the S. W. in S. 18, T. 12, R. 3, E., is a

very promising exposure of brown ore belonging to the *second horizon*. While some of it is very cherty and sandy, yet much of it is good. No openings had been made on the deposit to show the condition of the ore underground, or to what extent it may be mixed with rock or gravel, or the proportion of ore to the mass of matter. These matters could not be determined by inspection of the surface; yet the appearances indicate that it is a valuable though not a large body of ore.

The same ore is again seen in S. 14, T. 12, R. 2, E. It is there in much larger masses and greater volume, and again in S. 22 of the same township, where it is largely developed. High, red, ochery hills, apparently carrying brown ore, extend still farther to the S. W. and W. But little ore was seen, however, on their surface, and notwithstanding their iron appearance they may not be ore bearing.

Another small body of brown ore is found about one mile to the west of the last locality, in S. 21, T. 12, R. 2, E. It is not a thick deposit, and may not be valuable. It belongs higher up in the series. It is in the third Limonite horizon, and the absence of the Birmingham Breccia at this place puts it near the top of the Knox Dolomite.

In the N. W. corner of S. 28, same Tp., this stratum of brown ore again is found in large sized masses, though most of it impure and cherty. And in several places in S. 29 it is found in good sized pieces of good ore. But probably no body of it is sufficiently large to be valuable. Near the S. W. corner of this section there is a prominent point with its surface nearly covered with limonite. The ore is of good quality, and it is probably the best show of ore that is known at this horizon.

One mile to the south of this is the great Limonite Ore deposit of the valley, once known as "*Iron Ridge*," but now designated and known as

CHAMPION MINES.

This great deposit of brown ore belongs to the 1st Limonite Horizon, lying at the very base of the Silurian. Min-

ing has been progressing here for several years, operated by J. W. Worthington & Co., and under the efficient management of Dr. Walls. The mines are three miles eastward from ONEONTA—in S's 32 and 33 of T 12, and S's 4 and 5 of T 13, R. 2 E. The works are mainly in the adjacent S's 4 and 33.

Only two washers have as yet been started, these are supplied by water pumped into a large tank on the top of the ore ridge, and delivered by pipes to the washers as required. The daily out put is now about 300 tons which is shipped mainly to the furnaces at North Birmingham, by the Huntsville Branch of the Mineral R. R.

A Branch R. R. connects these mines with the present terminus of the Birmingham & Huntsville Mineral R. R., at Oneonta, and affords ample facilities for transportation. The ore of these mines by furnace test comes fully up to expectations. It carries less than 12 per cent. of silica—less than 25-100 of 1 per cent. of phosphorus, and yields from the furnace 56 per cent. of metallic iron. It is so easy of reduction, that the product of iron, in the small furnace at North Birmingham, is *15 tons per day, greater*, when using this ore, than when using any other that this valley affords.

These tests are practical, and every way satisfactory—they demonstrate that this is among the best, if not the *very best ore* found in Alabama.

A much larger out put of ore could be made here, did the iron market justify increased expenditure. An increased water supply, which has been arranged for, would enable the out put to be increased at will. The present water supply would not probably enable the company to greatly increase the product of well cleaned ore. Though by the use of *steam shovels* the out put was raised in 1891 to 10,000 tons per months; but as the ore was not always thoroughly cleaned, and freed from chert, they were discontinued.

These works carried on by J. W. Worthington & Co., have now been in operation over three years, and as yet they have made but a small impression on this great body

of ore. Only the top stratum, over a small area, has been worked. The greatest depth to which they have yet penetrated is 42 feet, and generally much less. The upper portion of this ore body, has the ore inclosed, or mixed with pulverent red ochery clay. Twenty-five solid feet of this mass yields one ton of ore on an average. This is about one-tenth in bulk of ore, but much more in weight. This light ochereous material is easily washed away, and the ore left clean.

Below this top stratum, of as yet unknown thickness, is another stratum, carrying apparently richer ore, but imbedded in tough, or unctious, red clay—hard to wash—the mining, or cleaning of which, has not as yet been attempted.

The foregoing notes embrace all the facts brought to light by three years mining on this deposit of ore.

A careful examination of all the exposed, adjacent and underlying rocks here, strongly impress the opinion, that this great body of iron ore occupies the site of a great basin, that existed here at the close of the Cambrian Period; and was filled in at the beginning of the Silurian Epoch. The extent, or form of this great basin, holding the deposit under consideration, can not yet be determined, or approximated. We can not learn from the exposures made, whether the axis of the basin conformed in any respect, to the axis of the uplift. Or whether the great fault which sheared through it, with much displacement, cut it in the *middle*, or on the *eastern* or the *western* side. Only of one thing can we be certain, that the axis of uplift, and the great fault heretofore described, cut this deposit from N. E. to S. W. for about a mile and a half; and for that distance exposed it on its N. W. side. While on the S. E. side, the corresponding portions of the deposit, are sunk from 1,500 to 2,000 feet beneath the surface. It is also probable that this deposit does not extend *westward* much, if any, farther than the west line of section 5. Though the great mass of iron clay, in which the ore is contained, extends a considerable distance beyond this line, but little ore has yet been

found in it. Deep boring only can determine its limits in a N. or N. E. direction.

It has been suggested that this deposit does not extend in a S. E. direction from the S. W. end of section 5—because on the face of the hill on the S. E. side of a deep gorge, the Cambrian Limestone is exposed, and no iron ore is there in connection with it. This is not conclusive evidence, the great fault is at the S. E. edge of the Cambrian Limestone, not at the gorge. Denudation here, as in many other places, has not followed the line of the fault. And the deposit of iron ore has here been swept away from the line of the fault, to the bluff on the opposite or S. W. side of the gorge. A similar condition of things exists a mile to the N. E. in section 4, where the principal denudation is *S. E. of the fault*, in the LaGrange sandstone—leaving a portion of Lower Siliceous, and Clinton strata, at the fault, *in direct contact with the great deposit of lower Silurian limonite*. It would also be an unreasonable supposition to conclude that this great body of ore was terminated by the fault on the S. E. side. That would be such an abrupt ending, as would be inconsistent with the laws governing sedimentary deposits; and such as has no where been seen in any other strata.

In the S. W. $\frac{1}{4}$ of Sect. 5 the best, and only approximate measurements, of this great bed were obtained. The top of the deposit is the best shown near the north line of that $\frac{1}{4}$ section. Thence is a gentle and unbroken descent, over the edge of the deposit, in a S. E. direction, for a distance of a little over 450 feet to the Cambrian rocks; difference of level by aneroid measure, 45 feet. The Cambrian limestone, on which the ore is bedded, here dips N. W. 60°. But this is believed to be an exceptionally steep dip. The members of that limestone here are *thin* and *shaly*; and it has been everywhere noticed in this formation, that the *thin members* have been crushed by the thicker, and more rigid ones, so that they dip at all angles. In estimating therefore the average dip of the strata, the dip of the thin shaly members must be disregarded, and the true dip of the strata obtained,

from the solid, heavy bedded, rigid members, whose dip is always found to be remarkably uniform.

At other points the dip found was always less than at the edge of the iron ore. It varied from place to place, but was no where to be found less than 10° . The average dip is certainly more, but to avoid an over estimate, it was hypothetically assumed that the dip of the iron ore is 10° N. W. That would give from the edge of the limestone a descent beneath a horizontal line, of 100 feet in 450—the length of the slant surface. To this must be added the descent of the surface in that distance, 45 feet. Making the *whole thickness of the deposit 145 feet*. But it is also probable that the limestone at this point, has been pushed up above the ore bed. It has that appearance. If so, the bed is thicker by the amount concealed by the limestone. It is also probable that the top of the slope, from whence the measure was taken, had been denuded, and was not therefore the actual top of the deposit. From all evidence therefore afforded here, it may be safely assumed, that this deposit is *150 feet thick*.

A little to the S. W. of this place, the limestone does not come to the surface, and the out-crop of the iron ore extends much farther down the hill, and therefore shows a much greater thickness of ore; but how much of this might be due to sliding, could not be determined, and hence no safe estimate could be made here.

A quarter of a mile to the N. E. and near the middle of the same section (5) a wash has cut through the iron ore deposit. The limestone beneath it is slightly exposed on the S. E. side. This is the extreme N. E. end of the exposure of the Cambrian Limestone. The iron ore deposit has been denuded down to the level of the floor of the valley in a N. W. direction. Its out crop along this wash is mainly obscured by silt, and shows but little ore. The edge here is over 200 yards broad, from S. E. to N. W.

On the face of the hill to the N. E. is shown from 150 to 200 feet of the iron clay which mainly constitutes the ore bed. The whole face of the hill is composed of it, but for a considerable distance no iron ore was found in it, and only

occasional chunks for a quarter of a mile. It is probable that the ore here, if it exists, is beneath the surface, and just above the limestone which here occupies a lower level. That it rises again in the N. E. $\frac{1}{4}$ of Sect. 5 and N. W. of S. 4 and E. $\frac{1}{4}$ of 33, is more than probable. The iron ore on these tracts shows boldly on the very top of the ridge and down for a considerable distance on its N. W. side. The ridge is about 200 feet high. Therefore either the limestone, the bed rock of the deposit, (for iron ore deposits always conform to their bed rocks), must be here pushed up, at least 100 feet above the base of the ridge, or the iron ore deposit must be assumed to have a very unreasonable thickness. All along this part of the ridge, the S. E. face of the deposit is masked, and the iron ore can only be seen near the top and on the N. W. side. The fault, as already noticed, is on the S. E. face of the ridge, and portions of *Clinton* and of *Sub-Carboniferous strata* are lapped up against the face of the *Lower Limonite deposit*. This effectually conceals the structure, and the probably underlying lime-rock. In this portion of the ridge, the ore is in larger masses, and in many places scattered more thickly over the surface, than toward the S. W. end. The breadth of the deposit exposed, and the quantity of iron seen, give no indication of the termination of the deposit. But the ridge sinks, and the *Lower Silurian strata* gradually close over it, toward the N. E. It is probable that the deposit extends farther, perhaps much farther in that direction.

It is much to be regretted that greater exposure or developments have not been made in this great deposit, especially as it is the only one of its age, yet known, in which iron ore is exposed, in this valley. Its ore is good throughout, none inferior; most of it the best of its class; it will yield throughout from 50 to 60 per cent. of metallic iron. A large per cent. of it is fibrous ore; in some places it is nearly all of this quality, in others, very little is seen. Taking the deposit all over, so far as yet seen, 20 to 25 per cent. of it is fibrous, or needle ore. It all carries less silica, and other

impurities, than is usual with limonite, and is therefore a very promising ore for the manufacture of steel.

Near this deposit on the S. E. side, is another deposit of limonite, which though locally adjacent to the Lower Limonite, is widely separated in geological position and time. It is the 5th deposit in the scale. It belongs to the Sub-Carboniferous horizon, just beneath the LaGrange sandstone. Its presence here adds much to the importance of this locality. And for the sake of greater compactness of description, will be presented here, out of its order, but in its association.

Immediately on the S. E. side of the great fault, in the S. W. $\frac{1}{4}$ of S. 5, T. 13, R. 2 E., is the exposed edge of a great deposit of limonite ore. On the N. W. side of it is a slice of Lower Siliceous strata, crumbled and comminuted, yet clearly showing the structure, and fossils of that period. A little farther to the S. W. the unmistakable Black Shale makes its appearance. On the South and Southeast of the ore, the LaGrange sandstone is plainly seen. The dip of all, as usual, is to the N. W. The geological position of this ore deposit is therefore demonstrated. The deposit appears to be about 50 feet thick. Though from evident slides on the S. E. side, its base could only be approximated. The upper portion of this deposit is generally too sandy. The larger portion of the ore is of that character for the upper eight or ten feet. Then a fair to good class of ore is carried, generally, in the remainder. The ore is not as uniformly good as in the Lower Limonite deposit, yet it has some ore equal to the best of that. Much of this ore is in large blocks and boulders, and it is evidently more closely compacted, with less iron clay associated with it, than the other deposit. The larger blocks are generally near the upper part of the deposit, while near the base, it is in smaller pieces.

Southwest from this point it soon disappears beneath the surface, and but little of it is seen farther down. It probably diminishes in volume very rapidly in that direction. In the S. E. $\frac{1}{4}$ of Sect. 5 most of the deposit has been swept away, only a thin stratum of its base is occasionally seen.

Neither does it show in the W. $\frac{1}{2}$ of S. 4, though it is probable that it exists here beneath the surface. But in the E. $\frac{1}{2}$ of Sect. 4 and the S. E. $\frac{1}{2}$ of Sect. 33, T. 12, R. 2 E., it again becomes very prominent. It appears to come out from beneath the Lower Siliceous Chert, and is lapped up against the base of the ridge of Lower Limonite. Thickness still about fifty feet. Its scattered fragments cover the low ground as far down as the denudation has gone. Its quality here will average better than in Sect. 5. It seems every way equal to the Lower Limonite, though generally of a lighter color, and showing less fibrous ore. Ascending the ore ridge at this point, one passes first over the thick outcrop of this ore for 50 feet vertical; next Lower Siliceous crumbled Chert 50 feet; then Clinton 50 feet; then Lower Limonite ore standing out of, and on the surface, about 50 feet more to the top. Heretofore it has been the opinion that the ore at the top and bottom of the ridge were the same. That the ore at the base had rolled, or tumbled from the top. Yet inspection of the surface would have shown that there are no masses, or chunks of ore, on the surface of the Clinton, or the Lower Siliceous; which would necessarily have been otherwise, if the ore at the base had come from the top. The inclination of the surface is such that masses of ore descending would have come to rest, on one part, as well as on another. Hence it might have been seen, even by those who did not understand the geological structure, that two different ore deposits exists here. But the deposit at the base of the ridge having been hitherto regarded as talus, has received no attention. Prospectors and specimen hunters have passed it by unheeded, or unaware of its existence. And yet it is one of the great iron ore deposits of the valley. It is true it extends N. W. only to the fault line. And that the N. E. and S. W. extensions of it may both be engulfed in the fault. Yet a mass of ore like this, 50 feet thick, and easily accessible, will not be overlooked in the future, as it has been in the past.

It is a remarkable freak of nature, which has here brought almost together, the *only bed* of lower limonite yet dis-

covered, and the *only valuable portion* of the 5th horizon, or Sub-Carboniferous Limonite. The *two best deposits* of this ore, which this valley contains, are here brought into such close proximity, as practically to make them one. The normal position of this Sub-Carboniferous ore is about 1,500 feet above the Lower Limonite, yet it is here brought to the same level on the S. W. end and 150 feet below it at the N. E. end of the exposure.

Another fact may be noticed, opposite the N. E. end of this limonite, a gap exists in the vertical wall, or edge of the valley, through which, and on the same level, can be reached several beds of coal, less than 1,000 feet distant from the iron. Thus making here a concentration of economic values, which probably cannot be paralleled. Should this coal prove suitable for the manufacture of iron, its apparent abundance and proximity to the ore, will give advantages for utilizing both in the vicinity, and greatly enhance their relative values.

In this great deposit of brown ore, there is no indication of any rock. It is a great mass of ochery, and ferruginous clay, with chunks, masses and particles of imbedded ore interspersed through it, apparently without regularity. In most places on the surface it is thickly strewn. If we should judge of the contents of the bed by the abundance of the surface specimens alone we should probably make an over-estimate, for the quantity on the surface is mainly due to denudation, which has carried off the surrounding clay, and left the iron ore. In some places the ore is in much greater quantities on the surface than in others; this may only be due in part to denudation. Probably the ore lies very irregularly scattered through the bed, in bunches and pockets, as is always the case in limonite deposits. The proportion therefore of clay to the ore, cannot as yet be safely approximated. In a few places where it has been dug into for a few feet, the proportion was about 3 or 4 of ore to 1 of clay, but these were places carefully selected, to show as much ore as possible, and none of them had gone deep enough to

be certainly beneath the effect of surface accumulation. It is probable that throughout the deposit the proportion of clay to ore may reach 10 to 1 in bulk.

This deposit is the only one certainly known to exist in the valley at this horizon. There are, however, good indications of the existence of another, a few miles farther down the valley. Here is in S. 14 and 22 the exposed edge of a vast deposit of iron clay and ochre, rising into a hill or ridge 200 feet high, and occupying the same geological position as the Iron Ridge or Champion Mines, and nearly as extensive. Though no iron ore is seen here on the surface, yet the probability of its existence in some part of this ochery ridge might be reasonably expected.

That no other than the Champion Mines deposit of brown ore, of this age, has been exposed in this valley is not a matter of much surprise. Only along a narrow strip about half a mile wide and ten or twelve miles long is the base of the Silurian revealed, and its exposure made possible. Part of that great deposit happened to lie in that strip and was thus exposed to view. While other bodies of ore lying a little farther to one side would only have their edges of iron clay laid bare, and the ores all hidden by overlying strata.

On the western side of the valley in S. 20, T. 13 of R. 1 E., there is a body of brown colored ore in chunks and masses which would ordinarily be classed as limonite. But only some pieces or parts of each chunk yield the characteristic yellow streak and powder of true Limonite ore. Other parts give a yellowish red or a bright blood red streak like Turgite ore. Yet it has neither the color nor appearance of either *Goethite* or *Turgite* ore. It must be classed as an *incomplete Limonite*, carrying less than the normal amount of water of hydration. This kind of ore is not common, only a few specimens had been heretofore seen. Were it abundant it would be more valuable than Limonite of the same grade of purity, because containing, say 5 per cent. less combined water, it has a correspondingly higher percentage of hematite in a given weight of ore. This deposit

is exposed only over a space of 20 or 30 yards long, and apparently 15 feet thick. No excavations have been made on it, and no safe opinion can be given of its contents. Its place is in, or closely connected with, the yellow magnesian limestone, at the 4th limonite horizon, or base of the Trenton.

Other bodies of this ore may exist farther down the valley to the southwest. The red hills on the Reese, Cowden and Higginbotham places, strongly suggest its vicinity; but the base of the Trenton is here beneath the surface; denudation has not cut down to the iron bearing horizon.

Near Village Springs, in S. 28, T. 14, R. 1 West, where the base of the Trenton is seen good limonite in large chunks was seen, but the quantity appears to be inconsiderable.

Of the limonites lying at a higher level on the west side of the valley, the best out crop is in S. 16, T. 12, R. 2, E., on the east side of the Calvert Fork of the Little Warrior. Large masses of very good ore are seen here in close connection with, but below the LaGrange sandstone. The ore is very dark colored, apparently carrying some admixture of manganese; this would reasonably be expected as this the 6th limonite horizon very nearly coincides with the manganese horizon in this valley. The ore bank has not been opened, and the natural exposure of ore is not sufficient to warrant the expectation of a large bed of it existing here. A few miles to the S. W., at this horizon is found a persistent bed of red chalk or red slaty ore, which seems in the main to have replaced the limonite. The ore is a lively red color, firm, slaty structure; smooth, fine grained, with silky lustre. It would be valuable if sufficient quantity exists, but so far as seen the bed or seam was only from six to eighteen inches thick. More or less of it was seen for two miles along Sand Valley, but mainly in S. 25 T. 12 R. 2 E. South west of this section none of it was seen, only small bunches and specimens of limonite mark this horizon to the S. W. end of the valley.

At the N. E. corner of S. 3, T. 13, R. 1, E., there is a fine exposure in a perpendicular face of the LaGrange sandstone

100 feet thick, and beneath in deep sink, of 15 feet of soft, dark, aluminous shale. Near the top of the shale is a thin stratum of very sulphurous iron ore. This being protected from the weather by the overhanging cliff, has produced by union of the sulphur and clay slate, a sulphate of alumina, or alum in an impure state; also sulphate of iron or *natural copperas*. This was the source from which the women of the surrounding region obtained material for dyeing articles of domestic manufacture in the hard times of the past.

On the opposite side of the valley in S's 13 and 23 of same Tp., was found brown ore in close connection with several thick sheets of yellowish red, hard stratified ore of low grade. And at one place in S. 13 a pit was sunk on a good show of limonite to the depth of 20 feet. At the depth of six feet the limonite had all been passed, and was replaced by a stratum of hard dark colored ferruginous material very lean in iron, three feet thick, but which gradually diminished to one foot at the bottom of the shaft. This was all inclosed in a great bed of white clay, with red streaks running through it, and having a distinctly acid taste. This is in the 5th limonite horizon and a little below the La-Grange sandstone.

At the same horizon in S. 24, T. 14, R 1, W., some large specimens of this ore were seen, south of Remlap station on the B. & H. Mineral R. R., and also in S. 23 of the same township. Here on a hill capped by LaGrange sandstone, and sloping down to the valley, is found a good show of very good limonite ore, though generally in small nodules. They are scattered along the face of the hill, apparently in two bands for a breadth of fifty to sixty yards. The lower band showed larger pieces than the upper one, and was evidently mixed with manganese. Some good specimens of manganiferous iron ore were found here, and also some good samples of pyrolusite. Unfortunately no excavation had been made on this ore, nor test pit sunk to expose its quantity or structure. From the surface indications alone, it was inferred that the deposit was sufficiently large to be of considerable value, and very favorably situated for easy min-

ing, and that manganese in some quantity and limonite were here either closely associated, or combined in the stratum. In this respect it is a very interesting locality; and it was much regretted that an exposure of the whole structure could not be obtained. Another good out crop of apparently the same ore is found in S. 34, T. 14, R. 1, W., and in S. 3, T. 15, R. 1, W. on the face of east Red Mountain. Some of it is seen near the top of the mountain where the public road crosses from Village Springs to Spradling's Cove, but it is gradually flexed downwards with the strata towards the S. W., and near the east line of section 3 its position is over 100 feet below the top of the mountain.

The ore is very good, and apparently abundant. The out crop covering a space of from 75 to 100 feet. But often out crops in the steep face of a mountain show a much greater thickness than the ore body possesses. It is probably so here. Yet if the body of ore is one-third or even one-fourth as thick as the out crops indicate, it is large enough for advantageous mining. The only uncertainty about the value of this lode is in the proportion of ore to waste matter it may carry. In this the cost of mining, and consequent value of an ore mine very greatly depend. In the absence of any excavation into this deposit, it is impossible to form any reliable opinion on this important point. When the demand for this class of ores becomes more pronounced this deposit will no doubt receive the consideration due to its apparent importance.

Many other small bodies of limonite have been observed at other points, which, from the small out crops presented, or their unfavorable surroundings, or the poor quality of ore were not considered likely to be valuable, and have not been mentioned. Two of the latter class lie about a mile from Village Springs, one north, the other north-east. The ore is very sandy, or mixed with chert--and yet this may only be the case with the upper part of the beds, which alone are seen. It is not uncommon for the upper layers of a limonite deposit to be sandy and worthless, and the lower

portion to carry good ore. Possibly this is the case in these deposits also.

Following these descriptions of the *quality*, *position*, and *location* of the limonite deposits of Murphree's Valley, we pass to a brief examination, and estimate of the *quantity* of this ore which this valley contains. This is necessary to give the reader some practical and definite idea of the magnitude, importance, and value of these ores, and the space they must fill in the future industrial development of the State.

ESTIMATES OF THE QUANTITY OF LIMONITE ORES IN MURPHREE'S VALLEY.

To estimate the quantity of ore in any deposit requires a knowledge of the thickness, and extent of the ore body; and of the proportion the ore bears to the waste materials which make up the bulk of the deposit. When these data are obtained, an estimate of the approximate quantity of ore in the body is a mere matter of calculation. We have not as yet the necessary data on any of the limonite deposits of the valley except on that great body of ore known as the *Champion Mines* deposit, including the adjacent Sub-Carboniferous ore.

The length of this deposit, in sight, is one and a half miles, or 2640 yards. Its breadth will average a quarter mile or 440 yards. Its depth 150 feet, or 50 yards—58,080,000 cubic yards. On an average it requires about or nearly three cubic yards of the body to yield a ton of clean washed ore. This ratio gives 19,360,000 tons of ore as the mineral contents of the lower Silurian deposit alone. To this must be added about one-fifth for the ore contained in the adjacent Sub-Carboniferous deposit, making by estimate the whole amount of ore at this place 23,232,000 tons.

The latest statistics puts the whole number of Iron Furnaces in the United States at 657, and their annual consumption of ore at 9,000,000 tons. At that rate of consumption there is enough ore at this place alone to supply all the



furnaces in the United States for more than *two years and a half*; or one of the large furnaces of the Birmingham District, running continuously, for more than three hundred years!

What amount of ore may be realized from the other limonite deposits of the valley is as yet a matter mostly of conjecture and speculation. But judging from their size, number, and their apparent capacities, it would be a conservative opinion, that in the aggregate they will yield more ore, by several million tons, than the Champion Mines deposit. This opinion may be predicated on the four larger deposits alone, without including the possible outcome of the numerous smaller ones, and hence that the capacity of this valley may be safely estimated at about 50,000,000 tons of available limonite ore.

As yet most of this superabundant raw material is unutilized. It awaits better facilities of transportation which will justify the extensive employment of capital and labor in its development. It is now probable that at no distant period the Huntsville Branch of the Mineral R. R. will be extended to make northern connections, and that the establishment of productive enterprises along its line will surely follow. With ample transportation furnished, this valley would afford facilities, and advantages for the cheap manufacture of iron, or its conversion into steel, or structural forms, unexcelled by any other portion of the State.

MANGANESE ORES.

Traces and samples of Manganese ores are found in many places. It is very widely disseminated, but the bodies, or deposits of it, are usually small. It has become of much importance in the arts, and hence always finds a ready market. It is used for the manufacture of chlorine, and bromine, and as a ready and easily available source of oxygen. It is also largely used for the improvement of steel; and for its production by the "Bessemer process," as well as several other purposes. The demand for it has more than kept pace with the supply. At present the larger portion of it used in the United States is imported from Europe. Yet even there the supply is limited. The total amount of it produced in the United States in 1882 was not quite 3,500 tons, while the importation the same year into the port of Baltimore alone, of Manganiferous ores, was 17,100 tons. It is probable that less than one-fourth of the amount used in this country is of domestic production. *The existence of deposits of Manganese ores in this region, is therefore a matter of much importance. And should the quantity prove as great as appearances indicate, and the quality prove satisfactory, it will add much value to this region.

As the ores of Manganese are not generally known, a brief description of the prominent ones will be properly presented here. There are *three* of them that are most common:

1. BLACK OXIDE — *Pyrolusite*. — Binoxide, Din oxide, Dioxide or Deutoxide. — One part of Manganese to two of Oxygen, or Manganese 63, Oxygen 37. It varies in color from light blue to dark grey, and to blue black or black. Hardness always less than lime spar; can be marked

*The production of Manganese in the U. S. increased to 34,000 tons in 1887, since which time it has decreased; being about 25,600 tons in 1890.

with a knife; *soils the fingers*; streak black, unmetallic, fine texture, granular or massive, brittle, cleavage not perfect, breaks in any direction.

A somewhat similar ore, but combining 10 per cent. of water, is called *Manganite*. It differs mainly from the Black Oxide in being harder, having perfect cleavage and being generally fibrous or columnar in structure.

2. **PSILOMELANE.**—This ore has not a definite chemical composition, but usually carries from 60 to 70 per cent. of dioxide of Manganese. This ore is harder than the preceding, and varies more in color, running from light brown to black. It is often associated with *pyrolusite*, in the same bed, or even in alternate layers. It can generally be distinguished by its greater hardness, and its streak being more reddish, or brownish, and shining, or sub-metallic.

Another variety resulting from one or all of the preceding ores is called *Wad*. It is generally soft or pulverent, often light, impure, much mixed with foreign matter. It has resulted in all cases from the decomposition of the other ores. And is not therefore of any definite chemical composition. Color always brown to black, *soils fingers freely*.

All these ores are known in the markets by the rather indefinite and uncertain name of "*per-oxide of Manganese*." That is an ore containing the largest amount of Oxide. But the market demands that they shall contain at least 60 per cent of it. Any ore which does not contain as much as 60 per cent of dioxide of Manganese is not saleable.

The 3rd common form is MANGANIFEROUS IRON ORE. It is so called because the oxide of iron predominates in it, over the oxide of Manganese. The respective oxides may vary between wide limits in different specimens; but when the dioxide of Manganese runs as low as 20, or even 30 per cent., and the oxide of iron predominates, it is called "*Manganiferous iron ore*." Its usual color is brown, blue black, or black; and in hardness and density it approximates limonite. A good deal of ore *often called pyrolusite*, properly belongs to this class.

THE GEOLOGICAL POSITION OF THE MANGANESE ORES.

Is in the Lower Siliceous group, from 50 to 150 feet above the Black Shale. Occasionally traces of them have been seen as high up as the LaGrange Sandstone.

DETAILS OF THE OCCURRENCES OF MANGANESE ORES.

A little southwest of where the Locust Fork of the Warrior crosses the valley, and on the N. W. side of Red Mountain, begins the first prominent exposures of these ores. They were first seen near the line between Sects. 14 and 15, T. 11, R. 3 East. The formation was clearly manganiferous. It soon presented a great body of manganiferous chert rock. This is a massive rock, apparently ten to fifteen feet thick, composed of chert, and compact quartz, cemented together, and commingled with oxide of manganese. These great bowlders are spotted with blue and white, as the seams of oxide show on the surface, or commingled with tints a light blue grey color. The thickness of this ledge of manganiferous chert could not be ascertained, as the dip was nearly the same as the slant of the surface. Ten to fifteen feet of it were seen, but it may be much thicker. A gorge 18 to 20 feet deep had here been washed out, the principal exposure of this rock is along its bed. On the west side of this gorge, and extending out over the top of the slant, to the S. W. and out into level ground, is a great bed of pulverulent black oxide of manganese, about four feet thick, and covering about an acre of ground. Many pits and holes had been dug in the "curious black stuff," long before its composition was known to the diggers. From all these holes it was seen, in depth, and quality to be very uniform, and to carry throughout the mass numerous small chunks of *pyrolusite*, and *manganite*.

These chunks are generally small, seldom more than two or three pounds weight, well rounded, and smooth on the surface, lying principally in seams and layers, and indicating growth and formation, rather than decay. Near the

bottom of the deposit, the ore chunks are more numerous, and seams of the pulverulent black oxide penetrate into the underlying clay. On the east side of the gorge this deposit is not seen. If it exists there, it is wholly covered over by earth and soil. But where it is seen on the west side, it is wholly on the surface, no rock, or soil covers it. No rock, except occasional pieces of soft chert, exists in it. The question naturally arises, how could such a formation have been produced? If resulting from decomposition like wad, it would have been more mixed with impurities. Its present position gives no indication of a basin. From whatever source it came, and however formed, it was certainly once roofed in with rock and solid earthy strata. These have been removed by erosion, and probably much of the manganese also. It is scattered for several hundred yards down the slope, north, and east of the deposit. Another similar deposit, but much smaller, was once on the surface about 300 yards to the south, and 80 feet higher. This was about two feet thick, and 20 to 30 feet in diameter. A deep test shaft was sunk here to see what lay beneath. Nothing was found, except small pieces, and seams, and dendritic incrustations of manganiferous matter on the rocks. These were very marked, until the shaft had penetrated strata, which owing to the dip, lay beyond the deposit. This shaft was sunk nearly 100 feet, but it did not reach the supposed underlying manganiferous chert. A marked feature in it was, the *loose, seamy and partly decomposed rock*, encountered in *all the strata lying beneath the manganese deposit*.

Owing to long exposure much of this surface deposit is decomposed, and without washing, would not give a high enough per centage. of dioxide of manganese to be marketable. The amount of salable ore that exists here cannot therefore be estimated, but it probably exceeds the annual product of all the mines in the United States. (1882.)

South-west from this large surface deposit about quarter of a mile, surface out crops of pyrolusite ore were plainly seen, and at nearly the same geologic level. These indicated a regular stratum of ore. It had been dug into in several

places, and showed good ore at all points. Thickness of solid ore from one to two feet. This out-crop was seen for about quarter of a mile. It is a little over half way down the N. W. slope of Red Mountain. At the top of the mountain above it, (but geologically in older strata, and at least 100 feet below it,) was seen a great bed of impure manganiferous matter, consisting of chert, silica, psilomelane, manganiferous iron ore, and pyrolusite, all mixed in varying proportions. Where this was cut into a few feet, the rocks became very hard, and were in regular layers. The openings only penetrated far enough to show three feet of this material. The surface indicated much more, it covered the brow of the mountain for a breadth of sixty feet. This bed, though differing in structure, is evidently the same as seen near the line of sections 14 and 15. It is very prominently exposed here for a quarter of a mile, then a gap intervenes; beyond that for over a 100 yards, it is wholly manganiferous iron ore, soft, of a dark blue color, and probably carrying 20 per cent. dioxide of manganese. This ore if free from phosphorus will be valuable. An exposure of the Black Shale near by showed only 50 feet of intervening strata, between it and this manganiferous bed. No opening had been made on the bed, its thickness is unknown, it shows on the surface for a breadth 20 to 30 feet, but as the out crop slopes down the hill, that gives no certain evidence of its thickness. This is near the line between S. 16 and 21, T. 11, R. 3, E.

Near the east side section 21 a gap exists in the mountain, and no signs of manganese were there visible. But in the remainder of the section it comes prominently to the surface in many places. In the N. E. $\frac{1}{4}$ it presents several fine exposures of manganiferous iron ore. Also a good out-crop of the same, and of better quality, was seen in N. W. $\frac{1}{4}$. But in S. W. $\frac{1}{4}$ several openings had been made, and the best show of pyrolusite ore yet seen is exhibited. In different holes dug on it, the thickness of the bed varied from two and a half to four feet. The extent, and form of the deposit is unknown. The ore is in chunks, nearly solid in the

bed, only a little ochery clay intervening. It comes almost to the surface—one to two feet of soil and clay only above it. No rock roof to give protection, it is therefore surprising to find the ore so good, and so little decomposed. This ore is judged to carry from 60 to 75 per cent. of dioxide of manganese. It is all pyrolusite. At least no samples of any other variety were seen. This is known as the *Dabb's bed*.

The discovery of this deposit was made in a field which had long been cultivated. At length the plows interfered with the top of the bed, and revealed its existence. Its position is about three-fourths of the distance down, from the top to the base of the mountain; and slopes N. W. down towards SAND VALLEY. It cannot be more than 75 feet beneath the LaGrange Sandstone, and probably 100 feet above the great out-crop of manganiferous material, which shows so prominently on the top of Red Mountain. Diligent, and close search was made, to find an intermediate bed, or deposit, but without avail. There is a strong probability of the existence of one, or more, in this space; but strata, or beds cropping outwards, on the face of a cherty slope, are in a very unfavorable position to be seen.

This deposit of manganese ore has only been slightly opened, on or near, its upper out-crop. No effort has been made to trace its outline, or show its contents at a lower level. Indeed it may be said, that no really intelligent search for manganese ores, has yet been made. The fact that they do not exist in regular strata, or continuous beds, that they have not a definite geological level, has confused and perplexed prospectors. Then they show very little sign of out-crop—their decomposition products, are scarcely distinguishable from the ever present oxides of iron. The drill, and auger will have to be mainly relied on to find the deposit, and much unprofitable labor will necessarily be expended. Yet from what is already seen, it is evident that this region contains large quantities of good ore, and that much of it lies so near the surface as to be very available.

In section 28, adjoining on the south, the great body of manganiferous matter was again seen, on the top of the

mountain. Close search was made down the N. W. slope for the out cropping beds of pure ore, which experience had shown may be always expected to exist, above a large body of this material. None was found till the base of the mountain was reached. Here at the lowest exposed level, in a wash, was a bed of good pyrolusite. It was not opened, had probably not been heretofore seen. It was near, or probably at a *higher* geological level than the Dabbs bed in the section above.

The line of the out crop of the base bed of manganiferous chert, was generally seen, and traced on the top of the mountain; and also frequent samples of good ore, seen near its base, from section 28, to the Township line on the south. No openings had been made on either, in this space, yet its existence here was plainly evident.

In Section 2, T. 12, R. 2 East, was seen the first clear evidence of it in this Township. Near the top of Red Mountain, in the N. E. $\frac{1}{4}$ of this Section, the base bed or deposit stands out very prominently. It is about three feet thick, and presents the appearance of a regular stratum. In structure it is chert, cemented with pyrolusite, of light blue color. It resembles, though it is not identical with, the great bed first seen in the Township above.

No beds or deposits of ore have been found on the slope of the mountain N. W. of this, yet it certainly exists there. At the foot of the mountain in this Section, some year or two ago, a well was dug, and a thick bed, represented to be six feet, of *wad* was passed through. This was said to be thirty-five feet from the surface. Some samples were still found among the clay, and other materials taken out. It was evidently decomposed manganese. From some cause it had at this place been subjected to decomposing agencies, and was in a plastic state, and saturated with water. That this condition is only local, is very probable. It is to be regretted that enterprise has not heretofore penetrated to this deposit at some other point. When its elements become known, and it is exposed, a good deposit of manganese ore will probably be found in connection with it.

In this part of the Sand Valley the base of the LaGrange Sandstone is on the foot slope of Red mountain. The search for manganese, so far as seen near here, had been at *too high* a geologic level above the base of this Sandstone. The position of this ore is *always* in the *Lower Siliceous* between the *Black Shale*, and the *base of the LaGrange*. The lower stratum of it has never been seen within less than fifty feet of the Black Shale, nor the upper one within less than fifty feet of the LaGrange. Its range is therefore a narrow one, not exceeding 150 feet, generally less. Persistent search in this narrow belt could hardly fail of discovering valuable deposits of ore, as yet, unknown.

In Sect. 10, T. 12, R. 2 East, some good samples of pyrolusite ore were seen, and a little in the adjacent S. 16, but no body was found. In S. 30, same Tp., a little body of it may be found. The characteristic out-crop of impure manganese is seen near the top of Red Mountain; and about its base in Sand Valley, were seen a number of pieces or chunks of hardened wad. It was nearly black, rather a brown black, crumbly, soiled the hands, and had all the usual characteristics of wad. What was seen of it had mainly been torn out of the surface dirt, hence no opinion could be formed of its quantity. It was only of interest as showing the existence of manganese at that locality. In quality, what was seen was impure, and probably did not contain over 15 per cent. of dioxide of manganese.

Nearly South of this place, in S. 6, of T. 13, R. 2 E., was found a thin bed, carrying iron and manganese, yet so blended as not to be classed as a definite ore of either; color various, from purple to reddish grey, and brown; streak brown, to reddish, iron largely predominant. The bed was less than a foot thick, and though of geologic interest, of very little value. In Sections 13 and 23, T. 13, R. 1 E., some similar examples of iron ore in beds were seen, with a small mixture of manganese. One of these was cut in a pit to the depth of 30 inches, it was not known that the bottom was reached. In color it varied from dark red to light, and dark grey, and to deep brown, and black. In hardness it

was equally variable. The black was generally pulverulent like black oxide of manganese, the grey, compact but soft, the reddish brown in intervening streaks of the usual hardness of soft iron ore. This constituted the largest part of the bed. This bed is in the proper manganese horizon, between the Black Shale and the LaGrange Sandstone, and from 50 to 80 feet beneath the latter. A hundred yards to the northeast were seen blocks and pieces of chert, cemented together with blue oxide of manganese. These, as has been seen, constitute a characteristic out-crop of manganese ores. They were here seen in a hollow, and at a lower level than the ore just described. Small pieces of pyrolusite were found scattered about. The locality is one worthy of careful search.

Nearly opposite to this place, on the other side of the valley, in Sect. 16, same Tp., was seen in a deep gorge an interesting out-crop of manganiferous material in a *compact bed*, about one foot thick, of a *soft, brown, crumbly, brown grey color*. This too is in the manganese horizon, probably 60 to 70 feet above the Black Shale. All the rocks above this bed were colored, and stained with manganese, in varying shades from light brown to blue black. Scattered, small pieces of its ore were picked up, and afforded additional evidence of its existence here, though none of its amount or quality. This is W. N. W. from where it was seen in S. 23, and it is possible that a manganiferous belt crosses the valley also in that direction.

The next promising locality where manganese was seen, is in S. 23, T. 14, R. 1 W. It has been already referred to in the description of the brown or limonite iron ores. Good chunks of pyrolusite, from 1 to 15 pounds weight, were seen here, scattered among masses of manganiferous iron ore. It strewn the ground along near the base of the hill for a hundred yards in length, and a breadth of twenty to thirty feet. The Black Shale is not exposed, and its proximity to that is unknown. Above it, and between it and the LaGrange Sandstone, is a bed of limonite ore, and about 100 feet of Lower Siliceous strata. Unless that formation is here of

unusual thickness, the manganese cannot be over 50 feet from the shale. It is clearly in the proper manganese horizon, and probably a small expenditure of labor here would show up a good bed of the ore.

South of this, in Spradling's Cove, several samples of very good ore were seen, but owing to the faulting here, but little of the proper manganese horizon is exposed—and that too, generally covered with silt. Experience having shown that it might be hopefully looked for in a N. W. direction, search was made for it in the Sand Valley in Sects. 20, 17, &c., of T. 14, R. 1 W. This portion of the valley is much silted up, and out-crops of strata are covered. No ore was found, but at several places exposed beds of blue and purple, crumbly clays, were strongly suggestive of its existence. These colored clays had not been seen elsewhere, they are in the proper horizon, and their coloring matter seemed to be manganese.

From the foregoing description the following conclusions may be drawn :

1. That the great bulk of the manganese ores of this valley will be found in the Sand Valley, and on the N. W. side of Red Mountain. The horizon of these ores is there, more or less exposed, the whole length of the valley, while on the S. E. side of the valley this stratum is in detached and broken fragments.

2. That the out-crops of the manganese beds or deposits are mostly on the N. W. side of Red Mountain, and are hence generally concealed by the descending debris. Or they are wholly covered up beneath the floor of the valley.

3. That the discoveries of these deposits have been in the main accidental, and cover but a *very small portion* of the ground where these ores are presumed to exist. And hence, that probably much the larger portion of them remain still undiscovered.

INDUSTRIAL MATERIALS.

Among the industrial materials found in this valley, brick clay, porcelain clay, limestone, building rock, fire-proof rock, and glass sand, are the most prominent.

BRICK CLAY.

Clay suitable for making building brick exists in many places. On nearly all the low lying or bottom lands a stratum of fine yellow clay, several feet thick, is found just beneath the surface. Especially is this the case along all the streams that flow in from the coal measures. These streams have silted down along their course a bed of yellow clay of very fine quality. It is free from chert or gravel, or particles of iron ore, which are hard to eliminate and which are always injurious to the brick, if worked in.

There are very many beds of clay belonging to the Cambrian Limestone formation. It is generally yellow, some places in great quantity. This is the ordinary flat woods yellow clay. It is native to that formation, and is found in all of our deep Silurian valleys. In some places it affords a good brick clay, but generally contains fine gravel, pieces of chert, and much iron oxide. These cannot be got rid of, and consequently the bricks made from it are rough and not of uniform texture or strength. The iron oxide generally contains sulphur, and this with the iron results in blistering and rapid decay. Such bricks will not make a smooth, strong, or durable wall. Much of this kind of clay has been used for making brick in the vicinity of Birmingham, and used in building the city. But used only because the market did not afford a better material, at a reasonable cost. Such bricks would not be sold to intelligent builders, if brought into competition with others free from their defects, and of uniform strength and texture.

The clay found along the streams, and in the low lands of this valley, is a different material. It has been washed up from its native beds, sorted and cleaned in *nature's sluice ways*, all the coarse materials dropped out, and the clay *re-deposited in beds of uniform quality*. It always contains enough fine sand to work easily, and mould smoothly. In the quantity of sand these beds gradually vary. As they recede from the coal field the sand gradually diminishes till they reach the Sand Valley. They will be found the best in the middle, or Red Mountain Valley. These beds are found on *all the streams* that cross the valley, except the *Locust* and *Blackburn forks* of the Warrior, which have generally brought down too much sand. This clay is abundant, and of fine quality along *Whippoorwill Creek*, and the streams that form the *Calvert Fork* of the Warrior, and *Mill Creek*, and in the future it will doubtless be largely utilized.*

HALLOYSITE OR PHOLERITE.

Among the industrial materials which may yet be utilized in this valley, is an extensive bed of Halloysite or Porcelain Clay. It lies near the base of the Lower Siliceous formation, a little above, often close to, the Black Shale. It varies in thickness and quality and color. Generally it is about three feet thick, white or nearly white. It would doubtless in many places make a good porcelain clay. Only its out-crop has been seen, which always contains more impurities than the average of the bed. But all porcelain clay requires washing, none of it is sufficiently pure to make good white ware in its natural condition. This bed could, like similar ones, be freed from its impurities by washing, and rendered fit for this purpose. This is the same bed that has for years been worked with satisfactory results near Valley Head in DeKalb County. And the fact that it there affords material

*Since the foregoing was written, examination has been made of the fine, strong, red bricks manufactured near Rome, Ga., from the clays found along the low lands of the Oostanula. These clays were found to be of similar origin and composition, seemingly identical, with the brick clays of Murphree's Valley.

of fine quality, gives hopes of yet finding it equally good, at other places where the same formation is exposed.

Whether any of this bed contains the proper proportion of silica and alumina to make fire proof brick, is not yet known. Some tests have been made, from a few places, without giving satisfaction, but these have not been sufficiently numerous to settle the question adversely.

HONE STONE.

Between the bed of halloysite clay and the Black Shale, generally close to the latter, there often exists a bed of very fine grit rock. Some of it is soft, and suitable for hone stones, or for the finest edged tools or instruments. Other portions harder and firmer, suitable for oil stones. Mechanics who have used these oil stones concur in regarding them as superior to any found in the market. Some of the stones had been accidentally found and used as whetstones and oil stones during the last forty years, but the position of the bed from whence they came was only discovered during the progress of this survey. It is mostly of a light yellow color, softer and of finer grain than novaculite. Has a finer texture and sharper grain than the Wachita oil stone. It will become better known in the future. Its position is on the western top or slope of Red Mountain—the very top member of the Lower Siliceous formation, just above the Black Shale.

BUILDING STONE.

Among the upper members of the Clinton are two ledges of sandstone, which in many places afford excellent building rock. One is a ledge of flaggy sandstone, highly fissile, with smooth faces. It may be split into any desired thickness. And wherever it is solid enough for use, it is the most conveniently utilized building rock this region affords. Its smooth faces which are perfect planes, and its uniform thickness, make it very desirable for strong, solid work. This kind of rock is only found at a few places, this ledge being generally shaly.

The other ledge of sandstone caps the upper iron ore bed. It is a very persistent ledge, usually about ten feet thick, though in a few places fifty or upwards. This is a massive, rather fine grained sand rock. Some of it is white, though the prevailing color is yellow. Some of it is variegated by concentric rings of deeper yellow or brown. These rings are from a quarter to a half inch broad, and the same distance apart. These rocks when dressed and put up present a very beautiful appearance, and could be made very ornamental. Almost everywhere this ledge contains good building material. Some quarries have been opened at the thicker places of the ledge and the rock has been found to work well, and is highly satisfactory so far as it has been used. In quantity it is inexhaustible, and for strength and durability cannot be excelled. The pillars of the 21st street bridge in Birmingham were obtained from this rock near Oneonta.

A good sandstone for building is also found on the brow, or near the edge of *Sand Mountain*. This is the upper members of the lower conglomerate. These members are in plates or layers of varying thickness, having smooth faces and good cleavage. It is therefore easily quarried and prepared for use. Blocks of any desired length and breadth could be conveniently obtained. These upper members of this rock are free from pebbles, a uniform, rather coarse grained, stratified sandstone. Owing to its position it is not easily accessible, and therefore has not as yet been extensively used. But should there be a demand for it in the future, roads to it can be readily built, or tramways to run it down the mountain.

The *LaGrange Sandstone* also in many places will afford a good material for building. It is generally white and massive, and may be quarried out in large blocks. But it has the disadvantage of imperfect cleavage, and it is soft and crumbly, and hence does not take a good dress. It is a *freestone* of open loose structure. It is therefore very re-

fractory to the action of fire, but as yet has mainly been used for inside lining for fireplaces, for which purpose it is well adapted. Whether its refractory character is sufficient to withstand a very high degree of heat, is not yet known. But as it is mainly pure Silica, and therefore alone infusible, the inferences are in its favor.

This rock would furnish large amounts of good material for the manufacture of *glass*. And the amount of it that has decomposed into *sand* along its base, will give inexhaustible quantities of that very useful material.

The *limestones* of the *Trenton*, and the *Sub-Carboniferous* formations, are both well exposed and very abundant. They both contain a superabundance of good building material, and of a character of already well known excellence for heavy work. And some of these, especially the latter, are well adapted for the manufacture of *lime* on a large scale. And as a *flux* for the reduction of the iron ores, their close proximity makes them of very great economic importance. This ledge of Carboniferous Limestone has only been tested at *Compton Mines*, but it extends in equal volume and purity the whole length of this valley.

FIRE PROOF ROCK.

Among the industrial materials in this valley, one of much probable importance, is a fire proof conglomerate. Its place is among the upper members of the Knox Dolomite in that debatable ground beneath the Trenton, where the Chazy belongs, wherever it exists. This rock has been seen at many places in the Silurian Valleys of Alabama, but nowhere in such abundance as in T. 13 of R. 1 E., in this valley. It is in some places nearly, or quite 100 feet thick. The lower members, where seen, were quartzite and breccia. The upper portion a more uniform and finer conglomerate. The small pebbly particles, nearly of uniform size, are generally flattened, of various colors, but mostly light yellow and white, giving the rock a light grey color. The rock is *firm, massive, strong, but porous or open jointed*. It has

enough cement to hold it firmly together, but is not filled with it, like most of the conglomerates of the Coal Measures. The rock appears to be mainly silica, with some alumina. The same materials of which fire bricks are made. In addition to this its mechanical structure renders it highly refractory. No fire test to which it has yet been subjected, affects its structure. At a white heat in a furnace, it neither melts nor decrepitates.

As these qualities of this rock have not hitherto been known, and are here only suggestively presented, it would be premature to decide definitely on its merits. They are however believed to be worthy of *immediate and thorough testing*. If this rock will fully answer the purpose for which fire bricks are now used, it will be much cheaper, and supply a want that has long been felt in this region. The rock is generally very accessible, very abundant, and having no cleavage planes, can be easily worked into any desired size or form.

A material sufficiently refractory, strong and durable for hearths, and lining of furnaces, is the only thing necessary in the manufacture of iron which this region has not hitherto supplied. Wide and persistent search among the clays has been made without satisfactory results. Perhaps among the rocks the "missing link" may be found, which will give to this region the *full complement* of necessary iron and steel making materials.

NOTE.—Years ago Mr. James Thomas informed the writer that the most satisfactory hearth for the Oxmoore Furnaces was a conglomerate rock. It has since been ascertained that *this was the rock* used there by him. It is classed by Mr. Hayes, U. S. G. Survey, as "The Birmingham Breccia."

CONCLUSION.

This description of the ores and industrial materials, so abundant in this valley, would be incomplete without a reference to its adaptation for their manufacture and utilization. *The contiguity of the raw materials*, the short transportation necessary to bring them all together are features that ought not to be omitted. It is a noticable feature throughout this valley. To this must be added, the abundance of water, both from large springs and everflowing streams. Most of these streams rise in the coal field on the S. E. side, and flow by sinuous courses across the valley. Several of these streams as they leave the valley, afford good water power. All of them are copious enough for steam and furnace use. Each one of these streams, from the coal field cuts a passage to the coal through which unlimited supplies of it may be obtained. Each of them as it leaves the valley makes a similar passage to the coal on the N. W. side. This is of special advantage, near the lower end of the valley where the supply of coal ceases on the S. E. side, the stream that there cuts through the N. W. rim opens a way into one of the best portions of the Warrior Coal Field. It is known as the Gurley Creek and Upper Warrior region. It has never yet been geologically examined by the State Survey, but is known to the writer, and therefore this statement is made advisedly.

Where the Calvert fork of the Little Warrior cuts the N. W. rim, access to the Berry Mountain coal, also of much value is easily obtained.

It will thus be readily perceived that with two lines of exposure of iron ores and one of Carboniferous limestone in this narrow valley, and ample coal accessible on both sides at its very edge, there must be economy in transportation of raw material that has not yet been elsewhere realized. Add

to this the further fact, that the streams which have cut accessible ways to the coal, have also cut the iron ore ridges and the limestone, and formed accessible ways to them. Hence the water supply is intermediate between the necessary raw materials, or may be so selected, that the ore, the flux and the fuel, may be brought together by the same track. The necessary distance that these would have to be carried would vary with location from half a mile to two miles only. Such contiguity of raw material and ample water has not been elsewhere seen; and probably does not exist anywhere else in the State of Alabama. But before any attempt to utilize these is made, careful and extensive tests of the coking qualities of the coal, and its adaptation to furnace use, should also be made. If this and the ores give satisfactory results, then evidently the manufacture of iron and steel will be more profitable here than elsewhere, by the difference in freighting the raw material.

Among the positions most favorable for furnace sites, and other industrial establishments, some have been already referred to and will not be repeated. A few others may very properly be mentioned. At *Village Springs*, near the lower end of the valley, the water supply is all that could be desired. Great fountains of the purest water gush out in many places. Large and small springs are numerous. These alone would be sufficient for the demands of manufacturing, and the use of a large population. But *Village Creek*, which affords good water power, also flows through the place. Down this creek a few miles is the *Gurley Creek* and *Warrior* coal basin. Iron ores of different kinds, and in great abundance, are in all the surrounding hills. The advantages of this location will not long be overlooked.

The *Blackburn Fork* of the *Warrior*, opening as it does an accessible route into the heart of the coal field on the S. E., also offers good manufacturing opportunities.

Mill Creek, which opens a way into both coal fields, and whose waters cut the brown and hematite ores, the sand and limestone, and are connected with large springs of good water, offers very desirable furnace sites. So do all the

Drainage of region.....	8
" Ancient.....	15, 59
Eastern Valley.....	13
Economic Geology.....	89
Estimates of Ores (red).....	87-8
" " (brown).....	108
Faults, under thrust.....	19
" description of.....	32, 33
" deepest part of.....	77
Flexures.....	54, 57
Fireproof rock.....	124
Formations, table of.....	11
Folds.....	28, 34
Fort Payne Chert.....	23
Furnace Sites.....	127
General Section.....	40
Geological Structure, table.....	11
" Formations.....	17
Geology, Economic.....	39
Glass Sand.....	124
Gothite Ore.....	104
Great Fault.....	19, 32, 33
Halloysite, porcelain clay.....	121
Hatches, quarries of.....	66
Head of Valley.....	7
" " end of Fold.....	38
Flexure of Valley, Fault at.....	38, 43
Hematites of Red Mountain.....	39
Hone Stone.....	122
Hoods X Roads.....	46
Hullett's Ores.....	77
" Gap, section.....	78
Jones' Valley, connection with.....	7
" " note on.....	7
Industrial Materials.....	120
Inverted Strata.....	22
Iron Ores of Clinton.....	39-88
Iron Ores, brown.....	86-108
Iron Limestone.....	43, 55, 60-62, 76, 79
Keokuk Limestone.....	24, 75

Keokuk Limestone, cave in	80
Knox Dolomite	25, 90, 91
Lagrange Sandstone	22
Limestone Mountain, or Bangor	20, 21, 83, 86
Limonite horizons	89-93
" Silurian	103
" Sub-Carb	101-106
" near Village Springs	107
Limonite, or Brown Ore, estimate of	108
Little's ore ridge	81-2
Manganese, ores of	45, 73, 82, 106
" " descriptions of	110-120
" " Geological position of	112
Manganite	111
Manganiferous iron ore	82, 111, 114
Murphree's Valley, Location and area	7
" " Drainage of	8
" " Structure of	28
" " Sections in	31
" " Mines in	65, 78, 95
Notes, on structure and formations of	7, 19, 22, 23, 26, 30, 39, 62
Ore Veins cut off by fault	70-72
Pelham Limestone	25
Porcelain Clay	121
Pot Ore	53
Psilomelane	111
Pyrolusite	110-115
Quarries at Compton	66
Quantity of Hematite ore	87-8
Red Mountain	14
" " Clinton of	39
" " Section of	40
East Red Mountain	85
Red Chalk	105
Reversed or inverted Strata	32, 37
Sand Valley	12
Sand Mountain	15
Sand—Glass Sand	124
Sections across valley	31

Section of Clinton.....	40
Silurian formations.....	25
Structure of Valley.....	28
Spradling's Cove.....	83
Sub-Carboniferous.....	20
Straight Mountain.....	13, 30
Synclinal on Southwest.....	7
" on Northwest.....	9
Table of Formations.....	11
Topography of Valley.....	10
Transverse folds.....	20, 34
Trenton.....	25
Turgite Ore.....	104
Turkey Creek ore bed.....	68
Village Springs great ore bed.....	63
" " water supply.....	127
Wad.....	111, 116, 117
Wade's Gap.....	75-6
Walnut Grove, Structure near.....	44-5

GEOLOGICAL SURVEY

—OF—

ALABAMA,

EUGENE ALLEN SMITH, Ph. D., State Geologist.

REPORT

ON THE

COAL MEASURES

OF

BLOUNT MOUNTAIN,

WITH MAP,

AND SECTIONS,

BY

A. M. GIBSON, ASSISTANT GEOLOGIST.

MONTGOMERY, ALA.:

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TABLE OF CONTENTS.

Letter of Transmittal.....	5
The Blount Mountain Coal Field.....	7
SECTION I. Introductory.....	7
General Outlines and Structure.....	8
The Interior Anticlinal.....	10
Drainage.....	11
Sub-Divisions.....	12
Blackburn River Basin.....	12
The Locust Fork Basin.....	12
The Calvert Fork Basin.....	12
Area.....	13
Vertical Measures of Straight Mountain.....	13
SECTION II. The Lower, or Sub-Conglomerate Coal Measures..	15
General Section of Sub-Conglomerate Measures..	18
SECTION III. The Upper, or True Coal Measures.....	19
The First Conglomerate.....	19
The Second Conglomerate.....	20
The Third Conglomerate.....	22
The Fourth Conglomerate.....	22
Exploration of the Field.....	23
General Section of the Super-Conglomerate Measures.....	28
SECTION IV. Detailed Description of the Coal Seams.....	31
Peacock Seam.....	31
Caskie Seam.....	32
Howard Seam.....	34
Lowe, Hullett, Garner Seam.....	36
Sand Creek Seam No. 1.....	39
Sand Creek Seam No. 2.....	39
Holt, or Big Seam.....	39
Supposed Waide Seam.....	40
Murray Seam.....	41
Ivy Hole Seam.....	44
Jourdan Seam.....	44
Adkins Spring Seam.....	45
Adkins Seam, Clements Seam.....	45
Mace Murphree Seam.....	47
Farley Seam.....	48
Series of thin unnamed seams.....	48
Fossiliferous or Guide Seam, Haynes Seam.....	49
Armstrong Seam.....	50
Woodward Seam.....	53
Phillips Seam, Lower Baine Seam.....	56
Carnes, Paine, Smith, Gaither Seam.....	59
Unnamed Seam.....	62
Bynum Seam.....	63
Top Seam.....	66
SECTION V. Unsettled questions.....	67
Waide Gap Seam.....	68
Allgood Gap Seam.....	69
Cowden Seam.....	69
Equivalent of Brock Seam.....	72
Quantity of Available Coal.....	73
Summary of Chemical Analysis of Coals.....	75

THE BLOUNT MOUNTAIN COAL FIELD.

SECTION I.

INTRODUCTORY.

The region lying between Murphree's Valley and Bristow's Cove on its N. W. side, and Cahaba, Coosa and Wills Valleys on its S. E. side is locally known by the name of *Blount Mountain*. It has long borne this name, rather to designate than to describe it. A part of it only can properly be considered a mountain, and only a part of it lies within the present, or the former confines of Blount county.

As the county boundaries now stand, the larger portion of it is in Blount, the balance in St. Clair and Etowah counties. The portions of it that may properly be classed as mountain, are its northwestern rim adjoining Murphree's Valley, and locally known as *Straight Mountain*—and its southeastern side which is still more elevated, and makes the top of the watershed between the Coosa and the Warrior drainage. This is the part that is properly called "*Blount Mountain*." This is a very prominent elevation, extending the whole length of this coal field, and with more or less prominence extending north-eastwards to the Tennessee River. Its height in the region under consideration is generally from 1300 to 1500 feet above sea level.

This coal area has been partially described in former publications, on "*The Warrior Coal Fields*," and on "*The Plateau Region of Alabama*." But these descriptions were necessarily brief and imperfect, a superficial reconnoissance only. They however showed this field to be one of importance—at least of sufficient importance to require more critical study and examination. The results of that study and examination are set forth as concisely as the subject would admit in the following pages.

An exhaustive report cannot be predicated on an untested coal field. Mining at different points, on the different seams, sufficiently extensive, can alone expose their qualities and geological characteristics. This only source of positive knowledge has been, and is yet, almost wholly wanting in this coal field. When the geological examination of this region was made no mining was being done; the seams which had been opened in former years, were abandoned, and the openings filled up, or caved in. Some of these were reopened, but others, and probably the most important, could not be, with the limited means at the disposal of the survey. Many new openings were made, and several seams of coal exposed, the existence of which had not been previously known. All of these will be referred to in their proper places in the details, and general description of the field.

GENERAL OUTLINES AND STRUCTURE.

This coal field extends from the S. E. corner of T. 14, R. 1 west in a north-easterly direction a distance of about forty miles, to the east side of T. 10, R. 5 east. From thence it gradually merges into "*The Plateau Region*" already described by Prof. McCalley. In width it varies considerably, starting in with a breadth less than three miles at the southwestern end, gradually widening out on the south east side till it attains a width of eight miles. At its widest part nearly opposite the town of Springville in St. Clair county, its southeastern edge is about three or three and a half miles from the northeastern end of the *Cahaba Coal Field*. It maintains its width of seven to eight miles to the middle of T. 13 of R. 3 east at Aughtery's Gap. From thence it gradually narrows around the edge of Greasy Cove. Opposite the middle of the Cove is its narrowest portion, scarcely three miles wide. From the township line between townships 11 and 12, R. 4 east, it widens perceptibly towards the northeast till it becomes 4 to 5 miles broad, which breadth it maintains to the upper or northeast end of the field. On its northwest side its margin is nearly a uniform

straight line running nearly N. E. and S. W. It is the southeastern edge of Bristow's Cove and Murphree's Valley, to the lower, or southwestern end of the field.

Although the southeastern edge of the valley is the actual northwestern edge of the coal field, yet the high elevation called *Straight Mountain* composed wholly of coal measure rocks, intervenes between the valley and the productive portion of the field. This is a high, narrow ridge with vertical strata; its general height is 300 to 400 feet above the valley. Its breadth from 1,000 to 1,500 feet, with 500 to 1,000 feet more of very highly inclined strata along its southeastern flank, or inner side. Hence, from 1,500 to 2,000 feet in breadth, along the edge of Murphree's Valley, which although it contains much coal, because not in available position for advantageous mining, must be regarded as unproductive. Toward the upper or northeastern end of Murphree's Valley this ridge gradually diminishes in height and volume, and northeast of the Locust Fork of the Warrior River its strata are changed gradually from the vertical to a highly inclined southeastern dip.

The dip of the strata in this field is mainly to the northwest, and generally about 10° to 12° , in a few places more, in many places less, except along the southeastern side of *Straight Mountain* which has a variable southeast dip, of 20° to 80° . Also a strip from one-quarter of a mile to two miles wide adjoining the mountain has a gentle southeast dip gradually diminishing to the horizontal. The field has the general features of an irregular synclinal with its lowest depression of strata near its northwestern side. The southeastern rim or *Blount Mountain* being elevated higher than *Straight Mountain*, the northwestern dips extend much farther than the southeastern; and these diverse dips do not meet as in a true or symmetrical synclinal fold, but both gradually diminish until they become imperceptible, and have a space of one to two miles broad of undisturbed horizontal strata between them. This general arrangement extends through the whole length of this coal field, but is more

marked, and distinctly prominent in the wider portions. It may in descriptions hereafter be referred to as a *trough*, but it must be remembered that it is a trough with a horizontal bottom, and that bottom much nearer the northwestern than the southeastern side.

THE INTERIOR ANTICLINAL.

Through the widest portion of this field, there is a well defined *anticlinal* starting from near the southwestern end of Greasy Cove and running west by south. It is about $\frac{1}{4}$ of a mile broad; it does not make a ridge, but is plainly and distinctly seen in the low lands where the streams have eroded the strata. It is particularly noticeable where it crosses Dearmond's Creek at the old Brasher Mill site, and Sand Creek at the upper end of the old Holt place. Also where it crosses Coal Bed Branch, and Difficulty Creek, to the Blackburn Fork of the Little Warrior River in T. 14, R. 1 east. Its course was traced about 10 miles, though it probably extends much farther. Its dip on the south by east and west by north sides is 10° , but its top appears to be unbroken. Its structure strongly suggests an underlying oil basin. And this suggestion is further strengthened by the fact that near the eastern end of this anticlinal, beneath the foot of the mountain a strong odor of escaping petroleum is perceived, and the slates of the lower coal measures are impregnated with oil, and burn freely in the fire. The underlying Trenton Limestone carrying much carbonate of magnesia is the great oil and gas producing rock—the source of the oil and gas in western Ohio, and eastern Indiana. This rock is of that character in the valley to the west, where it is largely exposed—whether it is of this necessary oil producing character beneath this anticlinal can only be determined by the drill. This matter must be left for future test and study.

At present we are only calling attention to the structure of this coal field, which has its symmetry in its widest portion marred and broken by this uplift passing diagonally through it.

DRAINAGE.

While the drainage from the top of Blount Mountain flows mainly with the dip of the strata to the northwest, into the head streams, or tributaries of the *Warrior River*; yet the area is distinctly divided into a series of basins by divides, or higher lands, which cross the field in a southeasterly and northwesterly direction, and make well defined watersheds between the head waters of these tributaries. The first of these divides near the southwest end of the field, crosses it near the surveyed line between Blount and St. Clair counties. Leaving *Straight Mountain* in section 19 and running east to section 22 in T. 14, R. 1 east is an elevation of land; a low flat divide between the *Canoe Creek*, and *Warrior River* drainage. From the top of *Buck Ridge* in said section 22, the dividing line of drainage is along the ridge northeast for about one mile; thence in a general northeasterly direction with the *Blount Mountain* to S. 8, T. 13 of R. 3 east. From thence in a general northwesterly direction along a high and broad plateau is the division of drainage between this basin, and the basin of the *Locust Fork* of the *Warrior*. The public road from *Murphree's Valley* to *Whitney*, generally, is near the top of this divide. from *Tait's Gap* in *Straight Mountain*, (S. 26, T. 12, R. 2 east) back to *Heathcock's*, and *Aughtery's Gaps* in *Blount Mountain*, in sections 16 and 21, T. 13 of R. 3 east. From *Tait's Gap* in *Straight Mountain*, southwestward, the boundary of drainage mainly coincides with that mountain to the beginning point. Only two small short streams break through it, one at the *Allgood Gap*, opposite the *Champion Mines*, the other at the *Clowdus Gap* three miles farther to the southwest. These two flow into the *Calvert Fork* of the *Little Warrior*. With the exception of these two small branches, all the drainage of the included area is into the *Blackburn Fork* of the *Little Warrior River*. This area may hence be appropriately referred to hereafter as the *Blackburn River Basin*.

SUB-DIVISIONS.

The Locust Fork Basin, begins at its southwest end on the high plateau of land which separates it from the Blackburn River Basin, thence to Blount Mountain on the southeast; thence with the top of said mountain to Gregory's Gap on the road from Walnut Grove to Attalla, in S. 24, T. 11, R. 4 east near the township line between ranges 4 and 5 east; thence north with said range line to Bristow's Cove. From Bristow's Cove southwestward with the edge of the cove, and the edge of Murphree's Valley to the line between Blount and Etowah counties; thence south along said line one mile to the top of the ridge north of the Hayse Gap; thence southwestwards along the top of this ridge to its junction with Straight Mountain near the south line of S. 18, T. 12 of R. 3 east; thence with said mountain to *Tait's Gap* the beginning point on the Blountsville & Whitney road.

All this included area is drained by the *Locust Fork* of the Warrior River—and may be properly called the *Locust Fork Basin*.

The upper, or northeastern end of this field, is a plateau region, drained mainly by *Line Creek*, and tributaries of Clear Creek, and other streams. It possesses a greater thickness of coal measures than the plateau region lying farther to the northeast, but not so great as the basins to the southwest. It carries several seams of coal that are identical with those in the Locust and Blackburn Rivers basins, and is hence an important portion of this coal field.

The remaining portion of the field, lying between the northwest boundary of the Locust Fork basin, and the Straight Mountain, is drained into the *Calvert Fork* of the Little Warrior River. It is a small area, but holds exposed some of the best, and most accessible coal seams in this field, and hence is of much economic importance.

AREA.

The area of this coal field is a little over one hundred and fifty square miles, exclusive of the sub-conglomerate measures, and of those that are vertical along, and near to Straight Mountain, and which for that reason may never be available or productive.

VERTICAL MEASURES OF STRAIGHT MOUNTAIN.

Much coal is shown to exist in the vertical and highly inclined measures of *Straight Mountain*, but its connection, or identity with the workable seams of this field has not been found, and it is not believed ever can be. Only the leading, prominent rocks of this vertical formation are distinguishable. Of these, the first prominent hard rock on its northwest side is the *Lower Conglomerate*, and its underlying shales and rocks of the sub-conglomerate formation lie between it and Murphree's Valley, making the northwestern slope of the mountain. The next and most prominent rock near the centre of the mountain and standing vertical is the *Second Conglomerate*. This is the most prominent and conspicuous rock of this uplift. Towering far above all its associates in this compressed mass of vertical rock and strata—bold and naked, like an artificial wall, from twenty-five to one hundred feet above its congeners, like the caruncle, or comb of a rooster's head, and hence popularly called the *Cock's Comb*. (This is the great massive rock which makes *Buck Ridge*, and part of *Bee Ridge* hereafter to be described, and farther to the northeast, makes in many places the crest of Blount Mountain.) Between this rock and the *Lower Conglomerate* (which makes the falls on all the streams cutting through Straight Mountain,) is the place for the Caskie, Howard and Peacock seams of coal; but they have not been found, except in detached fragments, and pockets in the rocks. So great has been the contortion, and pressure, brought on this uplifted section, that all soft material, shale and coal seams, have been squeezed out, and

all consecutive order obliterated, even in the intervening ledges of rock.

On the southeast side of the high vertical wall of *conglomerate rocks*, the rocks are compact, and vertical for one hundred and fifty to two hundred feet, then gradually assume a southeast dip with diminishing angles to the base of the mountain. A slight southeast dip continues for varying distances still farther to the southeast. Along the southeast side of the mountain, and especially near its base, seams of coal have been exposed, but all of irregular thickness, due evidently to greater or less compression, and also varying in strike from place to place. Some of this coal has been used in the shops, and with very satisfactory results; but all of these seams are too highly inclined to be mined to advantage; neither could any of these seams be certainly identified with those lying farther to the southeast. That they belong to that base group of productive measures lying above the *second conglomerate* is very evident, and probably near the middle of the group, and certainly *below the fourth conglomerate*, may be regarded as settled, but this is the closest approximation to their proper geological position as yet attained. The reason of all this will be apparent when the fact is considered that while this Straight Mountain is merely a fold of the coal measures, yet some portions of them are probably hidden by faulting, and that about 3,000 feet of strata are here compressed into a space of 700 to 1,000 feet horizontal measure, hence great compression, distortion, and displacement, necessarily resulted. These facts having been recognized, no further effort was made to develop, or study the *Straight Mountain* coals, and hence they are not included within the productive area of this coal field.

Also on the opposite, or southeastern side of this field is considerable area of lower or *sub-conglomerate coal measures*, which though they carry, at least in places, several seams of coal, yet all probably too thin to be of any practical value, and are hence not included here as productive

measures. This area embraces all the coal measures which lie between the top of the sub-carboniferous, or *Mountain Limestone* and the top of the *Lower Conglomerate*.

SECTION II.

THE LOWER, OR SUB-CONGLOMERATE COAL MEASURES.

This belt or strip of measures varies in thickness from 600 to 800 feet. It is seldom that the top and base of it can be both seen at the same part of the mountain. Except in a few places the *Mountain Limestone* is wholly beneath the floor of the valley, and where it is much elevated the lower conglomerate on top has generally suffered much abrasion, and is in many places wholly gone from the crest, and the body of the rock, covered up by soil or clay can not be seen. As a close approximation to its breadth it may be said that this strip of *sub-conglomerate coal measures* usually occupies the steepest part of the mountain, and varies from half a mile to a mile in width, nearly the whole length of this coal field.

This is the formation so carefully and extensively described by Prof. McCalley, Assistant State Geologist, in his report on "THE PLATEAU REGION OF ALABAMA." This is the formation that makes the "*Plateau Region*" in the main, though generally reinforced by a thin mantle of carboniferous strata lying above, and concealing the *lower conglomerate*. Farther to the northeast in Alabama, Georgia and Tennessee, this formation frequently carries thick seams of excellent coal, but of uncertain extent, and varying thickness. Want of uniformity in thickness, and want of continuity in extent, of the coal seams are characteristics of this formation, suggesting the possibility that they were formed in *basins* of greater or less extent, and varying volume, and hence have not the uniformity of the coal seams of a later period of the carboniferous era.

It is generally believed that the coal seams of this forma-

tion thin out towards the southwest, and are not in the Blount Mountain region of sufficient thickness to be of value. This opinion may be correct, many known facts seem to favor it, and yet it is an open question, the facts are mainly of a negative character, and are not conclusive. The same seam or seams occupying the same geological relations, that are prominent, and highly productive, in Georgia and Tennessee, have been traced from the Georgia line almost to the southwestern end of Blount Mountain. Of course this tracing was superficial and from the conditions on the face of mountain could not be continuous, for the southeast face of that steep mountain is generally a confused mass of slides, and but little of its strata can be seen in place, especially where the coal seams belong. But wherever the strata were found in place at the coal bearing horizon, and not buried by slides or talus, there the seams, or clear evidence of coal seams were found. Fossil coal plants in great numbers were seen in the rocks, almost continuously along the face of the mountain, and these were generally referable to the coal bearing horizons. This seems to be sufficient evidence of the continuity of this as a coal bearing formation. And the fact that the seams which were seen, were too thin to be worked, is not conclusive evidence, in this formation where want of uniformity is the rule, that they may not be thick in other places where they are not exposed.

Several prospect openings have in recent years been made in the face of the mountain to find coal, some of them give encouraging signs, but none of them have been driven in far enough to make a fair test. It will require the expenditure of much labor to make a satisfactory test at almost any point, and while in the present state of knowledge assurance of success cannot be given, yet neither should such efforts be discouraged.

While these *sub-conglomerate measures* must in our present state of knowledge, be classed as unproductive, yet they constitute an important member in the State's geological col-

umn, and hence require careful description. They are more prominently exposed along the southeast edge of Blount Mountain and contiguous elevations to the east and north-east than anywhere else in the State, and thus come appropriately within the bounds of this report.

These measures rest conformably on the top of the *Carboniferous* or *Mountain Limestone*. The transition, (where the junction was plainly seen,) is not abrupt, but the lime rock gradually passes into calcareous shale, and the shale gradually shows more and more silica in its upper layers till it passes into flaggy sandstone, of dark grey color near the base, and gradually changes into light brown friable sandstone towards the top. Somewhere near the base of this member a thin seam of coal exists, its position was not found on the face of the mountain, but pieces of it were found washed out of a deep hole in Canoe Creek where it ran over the rocks of this member. As the creek in its course, had not run over any higher member of the coal series, it evidently belonged here. The thickness of this member approximates one hundred and thirty feet. It is succeeded in ascending order, by a few feet of soft shale and clay, and a seam of good coal one foot thick where seen. This is succeeded by dark slate—dark grey to black, soft and fissile, eighty feet thick, followed by flaggy sand rock for twenty or twenty-five feet.

The next member, which may be local, consists of two beds of variegated crystallized limestone or marble, the lower bed four feet thick, very hard and solid, holding many fossils, and a good deal of silica—a very beautiful strong rock on which the weather seemed to have made no impression. About 20 feet above this bed is another of similar material and color, but softer, having less silica and fewer fossils. This ledge is also solid and about 20 feet thick. The prevailing colors are a mingling of yellow and brown. The thickness of this member where seen is about 45 feet.

This is followed by what is known as the "*Shaly Cliff*,"

a very prominent and persistent ledge of hard gnarly rock, often with bluff perpendicular face 20 to 50 feet high. This ledge is the great impediment to road making across this mountain, it only can be surmounted at a few places. The whole thickness of this member is about 100 feet.

Following this is a series of flaggy and ripple-marked sandstones, yellowish and reddish colored building stone, with belts of intervening yellow clay, somewhat irregular in volume, the whole making from 50 to 75 feet.

Above this member and near the base of the conglomerate next above it is, at least in places, a seam of coal of varying thickness, but so far as seen not exceeding one foot thick. This coal seam occupies the geological position of the *Cliff Seam*, *Etna Seam*, &c., so often referred to and described in Prof. McCalley's Report on the "PLATEAU REGION OF ALABAMA" that no doubt of its identity is intertained.

The *Lower Conglomerate* caps and complete the series of *Lower Coal Measures*. It is a rock so well and widely known that minute description of it is unnecessary. It possesses here its usual characteristics; a massive, persistent rock, varying in thickness from 50 to 100 feet, in some places, composed almost wholly of well rounded pebbles, firmly cemented together, and called *Millstone Grit*, in others the pebbles are in bands and patches, or sparsely scattered through the rock, while in other parts the pebbles are wholly wanting, and the rock is merely a coarse-grained sandstone.

The series of *Lower Coal Measures* will be presented at one view by the following:

SECTION OF LOWER OR SUB-CONGLOMERATE COAL MEASURES.

- | | | | |
|------|--|-----------|-------|
| (11) | FIRST, OR LOWER CONGLOMERATE | 50 to 100 | feet. |
| (10) | COAL (<i>Cliff seam</i> — <i>Etna seam</i> , &c.) | 1 | " |
| (9) | Flaggy sandstones and clay beds, | 50 to 75 | " |
| (8) | Shaly <i>Cliff</i> , | 100 | " |
| (7) | Signs of coal seam? <i>shale</i> , | 35 | " |

(6) <i>Limy or Marble group,</i>	45 feet.
(5) <i>Slate bed—dark grey to black,</i>	105 “
(4) <i>COAL—good quality,</i>	1 “
(3) <i>Flaggy sandstone and soft brown-stone,</i>	100? “
(2) <i>COAL—in Canoe Creek,</i>	? “
(1) <i>Flaggy sandstone (estimated)</i>	38 “

Mountain Limestone.

These measurements and estimates are probably too low in the aggregate; they were made at the lowest gaps, where the ascent of the mountain only was practicable. Besides this, while ascending the mountain towards the northwest, the dip of the strata, averaging about 10°, in the same direction, must be considered, this would carry the base of the measures a good deal lower beneath the top of the mountain than at its base. Hence it is considered that about 200 feet must be added to the measurements and estimates of the foregoing *section*, thus bringing up the whole vertical thickness to about 800 feet. In other words that from the average top of the mountain would require a perpendicular measure of 800 feet to reach the *Mountain Limestone*.

SECTION III.

THE UPPER OR TRUE COAL MEASURES.

Under this head are embraced all the known productive measures in this coal field. All that lie above the *First*, or *Lower Conglomerate*. The designation of this rock as the *First Conglomerate* is preferred, because there are *four distinct conglomerates* in this field, and it is easier, and more natural to designate and refer to them by their consecutive numbers, and natural order, than by any other means. These conglomerates are the guide lines, the geological land marks in the study of a coal area. They separate each series of coal seams from all others, and enable each to be examined in detail with greater certainty. Hence, the study of the conglomerate rocks of this field is first presented.

THE SECOND CONGLOMERATE.

This is the rock so often referred to in Prof. McCalley's report on the "PLATEAU REGION OF ALABAMA" and elsewhere, as the "*Upper Conglomerate*." It is truly designated there as the "*upper*," because it is so in fact, there being no other conglomerate above it. It is there generally the top rock of the series. But in this field it lies comparatively near the base of the *productive coal measures*. Probably the greatest horizontal distance between the top of the *First Conglomerate*, and the base of the *Second*, is 3050 feet, while the thickness of strata intervening is 336 feet. These figures are probably too high for a general average of thickness of strata, or distance between these rocks; but they were obtained at the only place found where measurements could be made with approximate accuracy; and are fairly representative for a large portion of this field.

This rock resembles the *First Conglomerate* in many respects, and general structure, yet differs from it so much in general appearance, that the one need never be mistaken for the other. Its pebbles are generally smaller, less crystalline, and less firmly cemented together, and where pebbles are wanting the rock is generally of a lighter grey color, and of more coarse quartzitic structure than the other. It is also in the region under consideration, much more massive and prominent than the *First Conglomerate*, often rising up very boldly above the surface with its outcrop covering a space of from a quarter to three quarters of a mile wide. That the thickness varies greatly is evident, but at no place has it been found possible to measure it, except by the space it occupies.

In the lower, or southwest end of the field, it comes near to the surface over a wide space, making all that portion drained into *Canoe Creek*, a plateau region. Its southeastern outcrop makes the ridge known as *Buck Ridge* from Fall Branch in T. 14, R. 1 E., and running thence north eastwardly through that Tp. and T. 14, R. 2 E., and T. 13, R. 3 E. It

crosses the Tp. line between T. 13 and T. 12 in S. 4 of 13 and 33 of T. 12, R. 3 E.; and in S. 34, T. 12, R. 3 E., near *Walker's Gap*, it reaches to the top of the mountain; and with the exception of two short spaces it makes the main top to S. 13, T. 12, R. 3 E., where it towers in the lofty naked masses known as "*Buzzard Rocks*." Opposite this point it was found that the *First Conglomerate* made the lowest bench on the southeastern face of the mountain, and that the Lower Coal measures were mainly buried beneath the floor of *Greasy Cove*, and that the coal seams lying between the *First* and *Second* conglomerates have their outcrops on the southeastern face of the mountain. Opposite here is the narrowest part of this coal field, the part lying between Greasy Cove, and the headwaters of the Locust Fork of the Warrior River; the cause of it is obvious, the uplift which produced Greasy Cove encroached largely on this coal field—indeed was wholly formed out of it; leaving only a margin of two and a half miles between its rim, and the Murphree's valley fold.

From the Gilland Gap, near the "*Buzzard Rocks*," in S. 13, T. 12, R. 3 E., the *Second Conglomerate* continues to make the top of the mountain to Tumbling Gap in S. 6, T. 12, R. 4, E. At this gap this rock is much broken up and displaced. The heaviest boulders are on the southeastern side of the mountain, and the First conglomerate still farther down towards the foot than at the Gilland Gap. This position of these rocks continues to the northeastward to Gregory's Gap in S. 19, T. 11, R. 5 E. on the road from Walnut Grove to Attalla; there the outcrop of Second conglomerate is wholly on the southeastern side of the mountain. It is only 100 feet thick, and is separated from the First conglomerate by only 110 feet of strata, while at Lyttleton on the T. & C. R. Road, near Line Creek in Secs. 17 and 20, T. 11, R. 5 E., it is at the level of the valley, and only separated from the vertical First conglomerate by a line of fault a mere seam in the rocks. But this is abnormal; for after passing up Line Creek above "*Buck's Pocket*" it assumes its normal

position on the face of the bluffs; and at the Sheffield Gap in S. 9, T. 11 of R. 5 E., it is again found at the top of the mountain.

Crossing the coal field northwestwards to *Bristow's Cove* the *Second Conglomerate* is again found making the upper part of the bluff on the east side, and extends with the bluff toward the southwest for several miles. This rim of the cove gradually declines in height toward the lower end of the cove, and sinks beneath the surface before reaching the Locust Fork of the Warrior River, and this rock too passes beneath the surface and is not seen again till it rises up in the middle of Straight Mountain near the Tp. line between Tps. 11 and 12 of R. 3, E. From thence it continues prominent to the southwestern end of Straight Mountain, as a vertical rock.

THE THIRD CONGLOMERATE

Is not a prominent rock, and may not be co-extensive with the coal field. Its place is near the middle of the productive measures. It is a coarse dark-colored rock in its upper parts, and near the base a reddish conglomerate formed of good-sized, but not well-rounded pebbles, firmly cemented together with carbonate of iron. Its place can be better explained when it is reached in the description of the coal seams.

THE FOURTH CONGLOMERATE

Is among the upper members of the coal measures in this field. There are but two seams of coal lying above it. It occupies but a small portion of the field, and is only found in a high flat-topped ridge lying between *Straight Mountain* and *Ponch Creek*, and the *Warrior River* below the mouth of Ponch Creek. It underlies the most of sections 17, 18 and 19 and part of 8, 9 and 3 of T. 12, R. 3 east.

The rock in the upper part is light-colored, loosely cemented, weathers badly, and is hence seldom seen on the surface; but its place is plainly shown by a profusion of

well-rounded, large-sized pebbles. Its lower part is irony, harder and better preserved. Owing to its disintegration and consequent want of face exposures, the thickness of the upper part could not be ascertained, but it is evidently thin—probably 10 to 15 feet thick. The lower or irony portion of this conglomerate is seemingly thicker. At one place its outcrop measured 40 feet, that might have been greater than the average.

For 100 feet below this conglomerate bed, the rocks are all quartzitic, many of them very granular. These, with the conglomerate above, to which they are allied, making a stratum 150 feet thick, and containing several good seams of coal, are peculiar to this section of the field, and make the top member of the Blount Mountain Coal Measures.

Whether this top series of conglomerate and quartzitic measures is the equivalent of the "*Montevallo Conglomerates*," the top series of the CAHABA COAL FIELD, or not, has not been determined, but is rendered somewhat probable by the geographical relation of the Fields, and their general similarity of structure. That one is the continuation of the other is evident. Both belong to that great strip of coal area cut off to the southeast by the great Jones Valley fold, and running a southwesterly direction; the direction in which it is known the Alabama Coal Measures mainly thicken. These Fields were originally *one*, and are now only separated by the branch valley, three miles wide, which connects the Jones Valley with the great Coosa Fold. It was, therefore, reasonable to expect a greater similarity between the strata and coals of *this Field* and the CAHABA immediately to the southeast of it, than between it and the WARRIOR FIELD farther to the northwest. This expectation has been reasonably verified in the progress of this survey.

The other prominent rocks and features of this Coal Field will be noticed under the head of "*Details*."

EXPLORATION OF THE FIELD.

In the beginning of the investigation of this Field a persistent effort was made to first develop the vertical and

highly inclined coal seams, in and near the base of Straight Mountain, and to assign them to their true position and relation to the other seams. Examination of seams was made and measurements taken in the *Cowden Gap* in section 28, in the *Waide Gap* in section 27, and in the *Clowdus Gap* in section 13, all in T. 13 of R. 1 east. Also in the *Allgood Gap* in S. 4, T. 12 of R. 2 east, with the following results: The outcrop of the *Cowden Seam* is in the S. E. of S. E. of S. 28, 515 feet southeast of the vertical rocks, average dip of strata in this space 15° southeast, height of seam above the highest of the vertical rocks, at the southeast base of Straight Mountain, 171 feet.

This seam varies in thickness from 3 feet 9 inches to 4 feet 6 inches. The coal is of low grade, impure, cokes imperfectly, gives a red ash. It shows here the following

SECTION:

<i>Roof</i> , yellowish-brown shale.....	Seen 6 feet.
COAL.....	30 inches.
<i>Slate</i> , dark, soft.....	4 inches.
COAL.....	16 inches.

Bed Rock, hard, gnarly, yellow-gray sandrock.

No other outcrop of coal was found up the branch toward the southeast from which the relation of this seam to those above or below it could be inferred.

About a mile southwest of the Cowden Gap opening, on "Dry Branch," a seam of coal was exposed which was classed as identical with the Cowden Seam, which showed the following

SECTION:

<i>Roof</i> , slate.....	
COAL, slaty.....	30 inches.
<i>Shale</i> , parting.....	7 inches.
COAL.....	15 inches.
<i>Clay</i> , dark.....	4 inches.

Bed Rock, hard sandstone.

Location in N. W. of S. W. of S. 33, T. 13, Range 1 east. This coal is of a little better quality than the seam in the Cowden Gap.

On the north side of the Blackburn Warrior in N. W. of N. W. of S. 4, T. 14, R. 1 east, another opening apparently on the same seam gave this

SECTION:

<i>Roof</i> , dark slate.....	
COAL, fair.....	30 inches.
<i>Shale</i> , parting.....	3 inches.
COAL, good.....	12 inches.
<i>Bed Rock</i> , sandstone.	

In the *Waide Gap* in the N. E. of S. E. of S. 27, T. 13, R. 1 east is a seam of coal which has been worked, and tested for some years past to a small extent, and known as the *Waide Seam*. This seam crops out 1,000 feet southeast of the vertical rocks of Straight Mountain. Its opening shows a slight northwest dip, which is doubtless produced by a small local wave. Coal of better quality than at the openings previously mentioned. It shows the following

SECTION:

<i>Cap Rock</i> , hard, curly sandstone.....	10 feet.
<i>Slate</i> , nearly black.....	25 feet.
COAL.....	2 feet 2 inches.
<i>Slate</i> , soft.....	2 inches.
COAL.....	1 foot 4 inches.
<i>Under Clay</i> , dark.....	4 inches.
<i>Bed Rock</i> , dark sand-stone.	

This coal gives a red ash, cokes reasonably well, is hard and glossy, with mainly cubical fracture. It has generally been regarded as identical with the Cowden Seam, yet as many points of difference, as of agreement with that seam,

are shown in its structure and surrounding. Its true position is not free from doubt.

In the *Clowdus Gap* in S. 13 the structure is yet more complicated. From the northwestern side of the Lower Conglomerate, measured southeastward, at right angle with the strike, to the first known vertical coal seam, the distance is 545 feet, and thence to southeastern side of vertical rocks 450 feet, making whole thickness of vertical strata 995 feet. The highly inclined strata dipping S. E. gives the following

SECTION:

- (1) From southeast side of vertical rocks to first known coal seam.....50 feet.
- (2) COAL, thin and irregular.....3 to 12 inches.
- (3) Slate, dark blue.....32 feet.
- (4) COAL, thin seam.....3 to 4 inches.
- (5) Slate, light blue to grey.....300 feet.
- (6) COAL, good, bright, hard, cokes well.....1 to 3 feet.
- (7) Slate, gray, and hard brownish gray sandstone.50 feet.
- (8) COAL, hard, brittle, cubical, (Saw Mill seam).22 inches.
- (9) Slate, hard light blue to gray.....60 feet.

It is evident from inspection of this section, that no point of identity with similarly located sections farther to the southwest, either in coal seams or strata, can be clearly perceived. It may be that seam No. (6) is the equivalent of the Waide, or Cowden Seam; but it carries much better coal, and is crushed and distorted to such a degree that its identity could only be a matter of inference.

The bed-rock of seam No. (8) alone, of all the strata seen in this section, bears a strong resemblance to the bed-rock of the Cowden Seam. But in all other particulars the two seams are wholly dissimilar.

That a fault, or slip in the strata, of unknown extent, exists in this gap, is evident from seams above No. (6) of the last section, not bearing the same relation to it, or to each

other, on both sides of the gap. One-fourth of a mile to the northeast of the line of the last section in southeast quarter of S. 18, T. 13, R. 2 east, we find Nos. 7, 8 and 9 of that section are wholly wanting, and are replaced by the following above No. 6:

FAULT SECTION.

- | | |
|--|------------------|
| (6) COAL, good, bright, hard, cokes well | 1 to 3 feet. |
| Shale, hard, irony. | 20 feet. |
| COAL, soft, thin seam | 4 inches. |
| Shale, hard, and sand-rock thin | 40 feet. |
| COAL, blackband seam | 2 feet 2 inches. |
| Sand rock, reddish, soft, and clay to top of hill. | 20 feet. |

Here, at least 110 feet of former section are replaced by totally different strata, that probably belong to a higher level.

The upper or Black Band seam shows the following

SECTION:

Roof hard, reddish sand-rock	6 feet.
COAL	4 inches.
Clay, parting	2 inches.
COAL	4 inches.
Black Band	4 inches.
Clay, parting	2 inches.
COAL	8 inches.
Fire Clay	

On the southwest side of the Gap (Clowdus) unconformity of strata is equally as apparent, but being more involved in the uplift of the Mountain, a fair section of it could not be obtained. The highest seam there found with a southeast dip was the Saw Mill Seam, No. 8, of the Gap Section. Its outcrop was found in a gully where there was much water, and it was so highly inclined that no satisfactory test could be made on it. Its thickness and importance are yet un-

known. Where its outcrop^a was first seen in the Gap, on nearly level ground, it was only 10 inches thick. A test pit was sunk 15 feet farther to the south, and in that distance it had increased to 22 inches of solid coal. But the seam being under water, and dipping downwards 8° to the south-east, no farther test could be made at that place. Should it continue to increase in thickness as indicated it will prove a valuable seam of coal.

From this point all the seams that were known, or could be found, were cut in succession across the Field, at its widest part, or toward the Arch. Walker Gap, in S. 36, T. 13, range 2 east. All the streams running into the Blackburn Fork of the Little Warrior, from both sides, were carefully searched for coal exposures, or indications, and all such found were tested. Then measurements were made across the Field from the top of the Lower Conglomerate at the eastern top of Blount Mountain, as nearly at right angles with the strike as practicable, to ascertain the thickness of strata between the respective seams, and the aggregate thickness of the coal measures.

To present the data thus obtained in a concise form, and to give greater clearness to the general description of the seams, a general section of the whole Field is given, including the upper seams, found only in the basin of the Locust Fork of the Warrior.

GENERAL SECTION OF THE SUPER-CONGLOMERATE MEASURES.

	Top of Measures—Clay, iron shale, soft sandstone.....	20 feet.
(28)	COAL, soft, no cap rock.....	2 feet.
	Shale, iron clay, sand-rock, some pebble....	30 feet.
(27)	COAL, the <i>Bynum</i> Seam.....	4 feet 4 inches.
	The 4th conglomerate and quartzite rocks...	80 feet.
(26)	COAL, seam not named; good, bright outcrop.....	1 foot 8 inches.
	Coarse sand-stone, flaggy.....	40 feet.

- (25) COAL, *Carnes, Paine, Smith, Gaither*
seam..... 3 feet 8 inches.
Quartzitic, sand-stone and clay..... 60 feet.
- (24) COAL, *Baine seam. Phillips seam?*... 3 feet 4 inches.
Flaggy sandstones, slates..... 65 feet.
- (23) COAL, *Fossil slate seam*..... 1 foot 2 inches.
Soft sandrock shales and clay, about..... 100 feet.
- (22) COAL, *Woodward seam*..... 2 feet to 3 feet 3 inches.
Hard arenaceous shale, and flaggy sand-
rocks..... 40 to 60 feet.
- (21) COAL, *Armstrong seam*.... 3 feet to 3 feet 5 inches.
Thin flaggy sandrock and slates..... 87 feet.
- (20) COAL, Thin seam—*Guide, or fossiliferous*
seam..... 1 foot.
Clay slate mainly..... 44 feet.
- (19) COAL, Thin seam not named..... 8 inches.
Sand rock 15 feet, flaggy rock and slates
20 feet..... 35 feet.
- (18) COAL, Thin seam.
Heavy bedded sand rock 20 feet, shales
and slates 60 feet..... 80 feet.
- (17) COAL, Thin seam.
Heavy sand rock 10 feet, flaggy sand rock
25 feet, shaly slate 25 feet, clay slate
12 feet..... 72 feet.
- (16) COAL, Thin seam, no name.
Heavy bedded sand rock 20 feet, flaggy
sand rocks 80 feet, clay slate and clay
2 feet..... 102 feet.
- (15) COAL, Thin seam, *The Farley*..... 1 foot.
Rock, hard massive, 25 feet, thin sandy
slates 90 feet, clay slates 26 feet..... 141 feet.
- (14) COAL, Double seam, separated by fossil-
iferous shale, *The Sally hole seam, Mace*
Murphree seam..... 1 to 2 feet.
Clay, slate and flaggy sand rock..... 69 feet.
- (13) COAL, *The Adkins seam, Clements seam,*
etc..... 4 feet 6 inches.

- Flaggy sand rock.....81 feet.
- (12) COAL, Thin seam—*Adkins spring seam*.
Flaggy sand rock increasing in thickness...82 feet.
- (11) COAL, The *Jourdan seam*.....2 feet 3 inches.
Flaggy rock, heavy bedded sand rock,
slate.....57 feet.
- (10) COAL, The *Ivy hole seam*. Third Con-
glomerate.....1 foot 7½ inches.
Shaly and thin bedded sandstone, slates....55 feet.
- (9) COAL, The *Murray seam*, *Washington seam*,
Jackson seam.....3 feet.
Soft shales, clay slates, hard gnarly rock
and dark slates.....100 feet.
- (8) COAL, Found only in deep water; sup-
posed *Waide seam*.....3 feet 6 inches.
Dark slates; sand rock, flaggy irregular....53 feet.
- (7) COAL, *Big seam*—*Holt seam*. Outcrop in
river drilled through; has several part-
ings; whole thickness.....12 feet 6 inches.
Thin sandrock and gray sandy slates, by
aneroid measure.....80 feet.
- (6) COAL, *Sand Creek, No. 2*. Thin seam.....1 foot.
Heavy hard sand rock, coarse flaggy
slates.....129 feet.
- (5) COAL, Soft impure in bed of Sand Creek.
Sand Creek, No. 1.....2 feet.
Hard compact rock, generally massive....312 feet.
- (4) COAL, *Garner, Lowe, Hullett, Aderholt*,
Brasher, Harris seam.....2 feet.
Flaggy to compact sandstone 250 to 300
feet, Conglomerate, 2nd 400 to 495 feet..795 feet.
- (3) COAL, *Howard seam*.....3 feet 6 inches.
Prismatic shale and clay slate.....125 feet.
- (2) COAL, *Caskie Seam*.....3 feet 8 inches.
Reddish colored sandstone, hard shale,
and compact building stone.....336 feet.
- (1) *Peacock Seam*—at outcrop.....1 foot 7½ inches.

Sand rock of various grades to top of 1st
or Lower Conglomerate.....56 feet.

Whole thickness of upper measures.....	3,415 feet.
And of lower measures (see section).....	800 "
Making whole depth of this Coal Field.....	4,215 "

SECTION IV.

DESCRIPTION OF COAL SEAMS.

DETAILS.

Seam No. 1, called the *Peacock Seam* from the iridescent sheen, or luster of part of its coal, was not discovered till near the close of the work in this field. It hence was not as fully tested and traced out as could have been desired. It was first discovered by digging a small pit on the lands of John C. Martin in S. 8, T. 14, R. 2 east, and in sinking a well in the southeast corner of said section; the seam was dug through near its outcrop. It was there 19 inches thick, solid coal, of very fine quality. This was 12 feet below the outer edge of the cap rock, and was not there considered a fair test of the thickness of this seam. It is believed from all the observed indications that this seam, when fully tested, will be found to be of workable thickness, and an important seam of coal. Indications of this seam could be traced southwest for about half a mile only, from the place where it was discovered. The rocks with which it is associated gradually thin out, and were not found any further in that direction.

Toward the northeast plain evidences of it were found as far as the Wm. Walker Gap in S. 34, T. 12, R. 3 east. It may not extend the whole length of the field. Probably it will be found only in that portion where the strata between the *First and Second Conglomerates* are thickest in townships 12, 13 and 14 of ranges 2 and 3 east. Over this part of the

field the space between these two conglomerates exceeds 500 feet, while toward either end it is diminished to 100 feet or less.

The composition of this coal, as determined by Dr. J. M. Pickel of the University of Alabama, is as follows :

ANALYSIS OF COAL OF PEACOCK SEAM.

Moisture.....	1.49
Volatile, combustible matter.....	32.38
Fixed carbon.....	61.46
Ash	4.67
	<hr/>
	100.00
Coke	66.13
Sulphur	1.79

The *Caskie Seam* No. 2 is apparently one of the best coal seams in this field. It was first opened by a Mr. Caskie many years ago, in the northeast corner of S. 10, T. 14, R. 2 east. An entry was driven in about 20 feet, and the coal coked and otherwise tested with very satisfactory results. This opening showed the following

SECTION:

Hard prismatic shale.....	20 feet.
Blue roofing slate.....	3 feet.
COAL, with some thin clay partings.....	3 feet 8 inches.
Under clay, dark, sandy.....	2 feet.

There is good evidence that this seam extends toward the southwest as far as the divide between the waters of the Blackburn Fork and Canoe Creek; and to the northeast as far as the examination of this field was extended, though probably not generally carrying its normal thickness.

At Maldin's Gap, in the S. W. $\frac{1}{4}$ of S. E. $\frac{1}{4}$ of S. 27, T. 12, R. 3 east, the *First and Second Conglomerates* are both plainly seen about a quarter of a mile apart. This distance,

with a dip of 10° northwest, would show the thickness of strata between them to be less than 250 feet. About the place where the Caskie Seam would be looked for there are good signs of coal. One large Chalybeate spring probably comes from this coal seam. Seemingly the coal is near the surface, but it would be an unfavorable place to prospect or dig for it. The Gap is a low one, with a cross fault running through it; much water accumulates, and many springs break out here which would be a great impediment to mining. This is the gap through which the T. A. & C. R. R. Co. have run the line of survey for the location of their road.

From this gap toward the northeast the second conglomerate makes the top the mountain mainly, and the seams lying beneath it are found on the face of the mountain. The debris and slides on the steep slope towards Greasy Cove have generally obscured the outcrop of this seam for many miles. Its position was seen and recognized at Gregory's Gap, in the southwest corner of S. 19, T. 11, R. 5 east, and also in the same section on one of the branches of Clear Creek. In this region the seam is thin, and the strata between the first and second conglomerates is reduced to 110 feet by aneroid measurement.

On Line Creek, in sections 8 and 17, T. 11, R. 5 east, this seam has again become thicker. Several openings have been made on it by Dr. Dozier and others. The works were closed up and a section could not be obtained. The reputed thickness is 30 inches solid coal. Its position was also seen here on the lands of Mr. Gordon, on the north side of the creek.

This seam was next found in S. 1, T. 11, R. 4 east, where it had been opened by G. B. Waide. The opening was made on the eastern rim of Bristow's Cove, 90 feet above the floor of the cove. The first conglomerate, not seen, its place is beneath the surface. The dip of the seam here is 60° east at the surface, but it is gradually lessened after passing the immediate rim of the cove to 10° or less in 200

yards. The opening was caved and filled up, but from Mr. Waide was obtained the following

SECTION:

Hard arenaceous sand rock.....10 feet.
 Blue clay, or decomposed blue slate.....4 feet.
 COAL, bright, glossy, nearly solid.....3 feet 10 inches.
Clay, parting.....4 inches.
 COAL, cubical.....4 inches.
 Under clay.

This coal, so far as seen, appears to be of good quality, and is reported to coke well and to work well in the blacksmith forge. It has not been as yet otherwise tested.

From the regularity of the uplift in the southeastern edge of the Cove, it is probable that this seam may be found at the proper level both above and below the Waide opening for a space of eight or ten miles. Toward the Locust Fork of the Warrior River it evidently is sunk downwards, passes beneath the river and is not seen any more on the north-western side of this field.

The *Howard Seam* No. 3 of the general section is found at the widest part of the field 125 feet above the Caskie Seam, and just beneath the base of the great second conglomerate rock. An opening was first made on this seam by Mr. Howard on the S. E. of N. E. of S. 9, T. 14, R. 2 east. It shows the following

SECTION:

Hard massive sand-rock at face.....12 feet.
 Yellowish-gray shale and blue slate.....10 feet.
 COAL, hard, bony.....1 foot.
 Dark shale parting..... $\frac{1}{2}$ inch to 2 inches.
 COAL, good.....2 feet 6 inches.
Fire Clay, bluish-white, very fine.....2 feet.

This seam, like the former one, (No. 2,) will not probably be found farther to the southwest than the drainage of the

Blackburn Fork of the Warrior extends in that direction. From thence toward the northeast its place is easily recognized, though often deeply hidden by debris piled up over its outcrop at the base of the second conglomerate. This base rock, which forms the cap rock of this seam, is generally a coarse sand-rock, seldom carrying pebbles, but always of such coarse grain and light gray color as to be readily recognized as a member of the second conglomerate.

At Malden's Gap, in S. W. of S. E. of S. 27, T. 12, R. 3 east, it is about a quarter of a mile northeast of the top of the mountain. Between Malden's and Gilland's Gaps it is on the very top of the mountain. It had here been dug into by Mr. Bynum years ago and some coal exposed, but not fully developed. In the region around Gilland's Gap, in N. E. of S. W. of S. 13, T. 12, R. 3 east, its place is about 200 feet below (S. E. of) the top of the mountain. A bold chalybeate spring breaks out here, known as the Gilland spring. Some digging had been done here and some coal and blackband ore exposed. The rocks contain many fossil coal plants and the position of the seam here is easily determined.

At Tumbling Gap in southeast of S. 6, T. 12, R. 4 east, its place was found on the southeastern face of the mountain, about 200 feet from the top. The strata here are too much broken up to warrant the successful opening of the seam at this place, though much more favorable places can be found on either side.

In S. 19, T. 11, R. 5 east, this seam had been opened by Mr. Copeland in two places. The seam is thin here, so far as cut into, only 15 inches thick, though its maximum certainly had not been reached. The coal is of fair quality, and further development may show better results.

On the breaks of Line Creek in sections 8 and 17, T. 11, R. 4 east, the strata are much broken and contorted, yet plain evidences of this seam were observed at several places. Near the second railroad bridge, on the north side of the creek, is a mural face of rock believed to be the second con-

glomerate, 125 feet thick, beneath which there is evidently a seam of coal; coaly, or bituminous shale, 4 feet thick, is exposed here. This is believed to be the outcrop of the Howard seam. Also, in section 9, same township, near the railroad track, a seam 20 inches thick is exposed in the railroad cut, which is provisionally considered to be the same. On the southeastern edge of Bristow's Cove the evidence of this seam was observed about 60 feet above the *Caskie seam*, and beneath the coarse disintegrated conglomerate which makes the top of the bluff, or eastern rim of the cove. It has not been opened anywhere on this side of the field, but though closer to the Caskie seam than on the other side of the field, no doubt is entertained of the identity of this and the Howard seam.

Like the other seams lying between the first and second conglomerates, this seam is not found on the northwestern side of the field at any place southwest of the Locust Fork of the Warrior River.

The *Lowe, Hullett, Garner seam*, No. 4, of the *General Section*, is the first known seam above the *Second Conglomerate*. It has long been known and highly esteemed for its uniformly excellent quality of coal. It is a very persistent seam, and bears throughout an almost uniform thickness of 23 inches. The quality of its coal very closely resembles the *Black Creek* seam of the Warrior Coal Field, but it does not occupy the same geological position. In a few places it has been seen only 21 inches thick, in others 26, and more rarely 30 inches. Over most of this field this is a solid seam of coal, but toward the southwestern end it has a small clay parting near the top. Mr. D. Aderholt has had some mining done by tunneling on this seam, in the W. $\frac{1}{2}$ of S. 4, T. 14, R. 2 east, and his opening gives the following

SECTION:

Flaggy reddish colored sand rock.....	15 feet.
Heavy shale.....	6 feet.
Blue slaty clay	5 feet.

COAL, hard bright cubical	9 inches.
Clay parting	1 inch.
COAL, hard lustrous	14 inches.
Fire clay bluish gray	2 feet.

In parts of this tunnel there were 27 inches of coal, but it again diminished to 23 inches.

An opening in S. 17, T. 14, R. 2 east, gave nearly the same section—coal 20 inches.

Two openings on the same seam on the east side of S. 11, T. 14, R. 1 east, gave this section:

Roof; shale	4 feet.
COAL, good	8 inches.
Shale, parting	1 inch.
COAL, good	12 inches.
Fire clay, floor	

This seam was not opened or traced further toward the southwest, but it probably extends in that direction as far, at least, as the divide between the Blackburn Warrior, and Canoe Creek drainage.

In a northeast direction from the Aderholt mine this seam is found on the east fork of Difficulty Creek, a little above its junction with the west fork, and is known as the *Hullett Seam*. On Coal Bed branch, in S. W. $\frac{1}{4}$ of S. 34, T. 13, R. 2 east, it was long ago opened and known as the *Lowe Seam*. On the N. E. $\frac{1}{4}$ of same section, on the west prong of *Sand Creek* it is called the *Garner Seam*. And in the N. E. of S. W. of S. 26, same township, at the Old Brasher Mill seat on *Dearmon Creek*, it was exposed at the side of the creek and known as the *Brasher Seam*. It is not seen and has not been opened on the divide between the Blackburn river basin and the Locust Fork basin, but is again found in the latter on Hurricane Creek, below Buttermilk Falls, near the junction of the east and west branches of the creek in S. W. $\frac{1}{4}$ of S. 32, T. 12, R. 3 east. Its outcrop here showed 23 inches of solid coal, with surroundings similar to the sections already given. Farther to the northeast its outcrop is

on the east side of Bee Ridge, and crossing the upper branches of the Locust Fork and branches of Pole Creek, about a mile northwest of the top of the second conglomerate. It was also opened at Harris' coal bed, in N. E. of S. E. of S. 15, T. 12, R. 3 east.

COAL SEAM No.—. On Hurricane Creek where it passes through *Bee Ridge*, in southwest of S. 32, T. 12, R. 3 east, near to the out-crop of Coal Seam No. 4, and 30 to 40 feet higher, is a Coal Seam, which is not given in the GENERAL SECTION, because it was not found elsewhere, though reported to exist also on Dearmon Creek, at a similar height above the *Brasher Seam*.

What the thickness, or importance of this seam may be, are matters of conjecture; its out-crop is beneath a heavy impending bluff which would crush it far below the normal thickness at the edge of the seam, even if it were not otherwise reduced by weathering. It shows this

SECTION.

Solid reddish cap rock, flaggy in upper part....	20 ft.
COAL, good.....	0 ft. 6 in.
<i>Shale</i> parting.....	0 ft. 2 in.
COAL, good.....	0 ft. 6 in.
Fire clay.....	1 ft. 6 in.
Clay Slate, with nodules of clay ironstone.....	6 ft.

Over this seam there is no covering of slate, but the coal is in immediate contact with the massive cap rock. It is a little wavy, and irregular in thickness, but this probably results from the unequal pressure of the overlying bluff.

That there may be other seams existing between Coal Seams Nos. 3 and 4 is very probable. They are over one mile apart, surface measure, and separated by nearly 800 feet of vertical strata. That all this mass of measures should be destitute of coal is improbable, but as yet no evidences of any have been discovered in this space.

COAL SEAM No. 5* is also known as the *Sand Creek Seam No. 1*. It does not give promise of being a seam of much importance. It was cut on the bottom lands, and in the bed of Sand Creek in S. 27, T. 13, R. 2 east, and on the hills facing the eastern Branch of Sand Creek, coal soft and brittle, seam about 2 feet thick, not used. It was also found in southeast of northeast of S. 31, T. 12, R. 3 east, in the Locust Fork Basin. Its position is about 315 feet above the *Lowe, Garner, Seam No. 4*, of the General Section.

About 130 feet above the Sand Creek seam No. 1 is found the *Sand Creek Seam No. 2*, No. 6 of the *General Section*. It carries good coal, but is a thin, and consequently unimportant seam, cut in southeast corner of S. 21, T. 13, R. 2 east.

Eighty feet above Sand Creek Seam No. 2 is the *Holt*, or *Big Seam*, No. 7 of the *General Section*. The out-crop of this seam was found only in the bed of the Blackburn Fork, and in deep water in Dearmon Creek. It could not be tested, or exposed by digging above water level, nor could samples of its coal be obtained for analysis. Testing was done by drilling through the seam, the record of which gave the following detailed

SECTION.

Roof, clay slate.....	5 feet.
COAL.....	0 foot 4 in.
Clay Slate.....	1 foot 5 in.
COAL.....	0 foot 3 in.
Clay.....	1 foot 5 in.
COAL.....	1 foot 6½ in.
Rock parting.....	2 feet 0 in.
Slate and Coal.....	1 foot 3 in.
Coal and Clay.....	0 foot 6 in.
COAL, hard.....	1 foot 6½ in.

* No. 5 is called in the vicinity, the *Upper Sand Creek seam*, and No. 6 the *Lower Sand Creek seam*, but as these names give a false idea of their relative position, we have substituted the names Sand Creek Seams No. 1 and No. 2.

Clay	0 foot 6 in.
<i>Blackband and Coal</i>:	1 foot 11 in.
Clay.....	0 foot 4 in.

Hard rock supposed to be bed rock.

Whole thickness of seam 12 feet 6 inches. Drilling done in southwest of southwest of S. 22, T. 13 of R. 2 east.

It cannot yet be known if this drilling gives an average section of this seam. The small amount of under clay here, seems not to be in proportion to the thickness of the seam. And the absence of any clay above the rock parting excludes the idea of its being a *double* seam. Then the rock parting may be local; at one opening made on the Howard seam No. 3, a very hard rock was encountered imbedded in the coal; that opening was abandoned, and another made 100 yards farther east, where no such rock existed.

Where this seam crosses Dearmon Creek in N. E. $\frac{1}{4}$ of S. 22, T. 13, R. 2 east, a better view of its surroundings was obtained; though the seam being cut by the creek in deep water nothing could be there learned of its size or structure. Large amounts of coal were washed out here by the great flood of July, 1872. Wagon loads of it were gathered up and hauled off in after years.

About 55 feet above this seam is another one cut by this creek, No. 8 of the *General Section*. It also is cut in deep water, and while the coal could be distinctly felt with a pole, yet only, the surroundings of the seam could be seen. It is overlaid by 8 to 10 feet of dark slate, and 10 feet of hard gnarly cap rock. This rock weathers out rough and scaly, giving it an appearance readily recognized. The slates and this cap rock very much resemble, if they are not identical with, the slates and cap rock, over the *Waide seam* in S. 27, T. 13, R. 1 east, heretofore mentioned. While this evidence alone is not conclusive on the question of identity of seams, yet taken in connection with the fact that no other seam in this Field has as much similarity in surroundings, gives their supposed identity a degree of probability. From the evidence obtained it seems to be a necessary inference that



the *Waide seam* on the northwest side of the Field must be the equivalent, either of this seam, or of the one next above it, the *Murray seam*, next to be described.

This seam has not its out-crops exposed farther to the northeast than the middle of S. 23, T. 13, R. 2 east; or if so, it has not been observed. This may arise from the fact that the dip of the seam. and the steep slope of the hills, are both in the same direction, and all signs of it are hidden by the descending debris. Towards the southwestern end of the Field there are two places where coal is torn up in deep holes in the river; one in S. 31, T. 13, R. 2 east; the other in S. 10, T. 14, R. 1 east, which from their location are believed to be on the southeastern out-crop of this seam.

No. 9 of the *General Section* is known as the *Murray seam*, because it was first discovered on the lands of John Murray in northeast of northwest of S. 22, T. 13, R. 2 east. It was here cut by the river, and exposed in its bed, mostly under water. Coal, bronze shade, brittle breaking up into small cubes, good quality, cokes well, a good blacksmith coal. As exposed here the seam was only 17 inches thick, in two benches, with clay parting of 4 inches near the middle. Believing that a larger seam of coal existed here than was shown in the river, and to test it, and to show its relations test pits were sunk on the seam 200 yards to the southeast and one-quarter of a mile to the southeast of the river, and also a drill hole sunk to bed rock below the seam in the river. These tests showed that there were two small subsidiary seams of coal, one 8 feet *above*, the other nearly 4 feet *below* this seam, and that all the intermediate slates were a *mass of fossil coal plants*. The coal seam was just the same in the test pits as where cut by the river. It was made evident, however, that enough carbonaceous matter existed here to make a large seam of coal, if circumstances elsewhere admitted of its being all combined into one bed. That this should be the case in some other part of the field is very probable, and gives this seam a great prospective importance. It shows at this place the following

SECTION:

Cap rock, hard, rough, compact, shaly.....	10 feet
Shales and clay slates.....	6 feet
Coal, poor.....	0 foot 3 inches
Slates dark, very fossiliferous.....	8 feet
COAL, brittle, cubical.....	7 inches
Clay parting.....	4 inches
COAL, brittle, cubical.....	6 inches
Clay.....	2 feet 0 inches
Slate, fossiliferous.....	1 foot 8 inches
COAL.....	6 inches
Under clay.....	4 inches
Bed rock.	

The cap rock of this seam being easily distinguished from other rocks, was traced in an east to northeast direction to where it crosses the Blountsville & Asheville road, about three-quarters of a mile northeast of Foster's Old Chapel, thence north with the slope of the hills to the river again at the lower end of P. Clements' place, in S. W. of N. W. of S. 23, T. 13, R. 2 E., very near the corner of the section; may be in the N. E. of N. E. of S. 22. The seam was found here to be much improved, and the slates above it to have but few fossils. Coal very greatly improved. The upper bench of it has long been known, and highly appreciated by the local smiths. It is classed by them as the best coal in the Field, some of large experience say it is the best coal they ever used. The lower and more important part of the seam was discovered and brought to light by the Geological Survey. It is a notable feature of this field, and also of the Cahaba, that many of the seams have clay partings; these *partings* have in many instances been mistaken for *under clay*, and the most important portion of the seams overlooked. Other instances of the same kind will be given hereafter.

This seam shows here the following

SECTION:

Slate in river bed.....	5½ inches
COAL, bright, glossy, good.....	10½ inches
Clay parting.....	7 inches
COAL, like upper bench.....	18½ inches
Under clay.....	.2 feet
Hard slate.....	1 foot 8 inches
Bed rock.	

In one mile this coal has increased in thickness 16 inches. It is here in a bed 29 inches thick, exclusive of under clay and roofing slate. Ample thickness for mining, and carrying coal that would take the lead in any market.

The seam could be opened near this place on either side of the river, above water level, and with natural drainage.

Whether this seam continues to increase toward the northeast cannot now be known, as its outcrop is covered by the bottom lands of the Blackburn Warrior in that direction to the broad divide between that stream and the Locust Fork basin. That it can be found and opened in this space there is no doubt, but it will require careful search to locate it.

Northeast of the divide this seam was certainly seen at but one place in the Locust Fork basin. On a branch on the lands of John Jackson, near the northeast corner of S. 32, T. 12, R. 3 E., the peculiar cap rock of this seam was observed. Coal had here been worked out of the upper bench of this seam 14 to 18 inches thick. The clay parting, as in many other places, was doubtless considered the base of the seam. If the lower bench, which no doubt exists here as elsewhere, has thickened in proportion with the upper one, or even to the same extent, this is here a very fine seam of coal. A proportionate increase of the lower bench of coal which is reasonable to expect, would give here over 4 feet of coal.

Toward the southwestern end of the field this seam is certainly known to have been cut at but one place, near the

mouth of Armstrong's Creek in S. 31, T. 13, R. 2 East. It is there known as the *Washington bed*. Coal has been taken out here in considerable quantities in former years, though the works are now filled up.

The coal here, as in all other places on this seam, is in two benches, with a clay parting between. Coal of very fine quality about 20 inches thick. Not thick enough for mining, here, or probably anywhere else in the southwestern part of this field.

Immediately above this seam at the Washington beds is the *third conglomerate*. Generally it is an iron conglomerate holding rather large-sized pebbles, and very firmly cemented together with carbonate of iron. It may not be co-extensive with the field; was only seen at, and south of, the Washington bed, and on the river bluff at this horizon, in S. 21, T. 13, R. 2 East.

No 10, of the *General Section*, is about 55 feet above the Murray Seam, and is locally known as the "*Ivy Hole*" seam, so called from the large amount of ivy growing near to the deep hole in the river where this seam was first observed.

At the place where it was first opened near the southeast corner of the N. E. of N. W. of S. 22, T. 13, R. 2 East, it was only $13\frac{1}{2}$ inches thick, and so far as traced on the river bluffs to the southwest seemed about to hold its own. But to the northeast it thickens a little. In the S. E. of S. E. of S. 15, T. 13, R. 2 E., it was drilled through at the edge of the water and found to be $19\frac{1}{2}$ inches thick. Should this increase continue a mile farther northeast it would become a workable seam.

From 55 to 60 feet higher up—strata, flaggy sandrock—is the Jourdan Seam, No. 11 of the *General Section*. It is called the "*Jourdan Seam*" because it was first opened on Jourdan Creek in the N. W. $\frac{1}{4}$ of S. 14, T. 13 of R. 2 East. This was a very promising outcrop of coal, capped by a heavy ledge of sand rock, and lying above water level.

Its outcrop showed the following

SECTION:

Cap rock, heavy bedded sand rocks.....	8 feet
Slate and shale.....	2 feet
COAL.....	7 inches
Slate parting.....	3 inches
COAL.....	1 foot 5 inches
Fire clay.	

It was expected that this would develop into a workable seam. The coal was evidently of good quality, but further development did not show any increase in the thickness of the seam; and at other openings made on it farther to the southwest the seam was thinner and less promising than on Jourdan Creek. It may be increased in volume towards the northeast, and in the divide between the Blackburn and Locust Fork basins, but in the latter it was found to be a thin seam.

Eighty feet above the Jourdan Seam is the Adkins Spring Seam No. 12 of the *General Section*. It is a thin and unimportant seam. The intervening strata generally above and below it are thin bedded, flaggy sandstone, with intercalated beds of clay slate.

Eighty feet above No. 12 is the *Adkins Seam* No. 13 of the *General Section*.

This seam was partly exposed in the bed of the Blackburn Fork of the Little Warrior. It had long been known, and its coal was highly appreciated. But all the coal taken out here for years past was out of the upper bench of the seam, which alone was known to exist. An examination made here by the Geological Survey showed that the clay beneath this coal had not the characteristics of *under clay*, but of a clay parting in a coal seam. The drill was applied and the lower and most important portion of the seam discovered. Location in N. E. of N. W. of S. 22, T. 13 South, R. 2 East.

This seam gives the following

SECTION:

<i>Roof, clay slate.</i>	
COAL, good.....	9½ inches
Clay parting.....	1 foot 6 inches
COAL.....	2 feet 2 inches
<i>Under clay</i>	2 feet

Whole thickness of coal nearly 3 feet.

Thickness of seam, 4 feet 5½ inches.

Dip of strata, 4° N. W.

It was readily seen that a short distance below, or south of this bed, this seam could be opened above water level, and at a right angle with the strike, so as to secure natural drainage. A most eligible and desirable position for mining. This coal is known to be an excellent shop coal—that determines its merits, because a good shop coal must necessarily be a good coking and furnace coal. It must be low in sulphur, high in fixed carbon, coking well and easily, and producing but little clinker; hence a good shop coal must necessarily be a good all-round heating, steam and furnace coal.

It is a very peculiar fact that the *Murray Seam* No. 9 and the *Adkins Seam* No. 13, lying within less than 300 feet of each other, and carrying the best coal as yet passed over in this description, have both very thick clay partings, the removal of which will probably somewhat increase the cost of mining the coal, but the coal from either seam, when put on the market, will command a price that will fully compensate for any increased cost of its production. Both seams are so situated as to afford excellent facilities for operating self draining mines above water level, and accessible to any mode of transportation.

The next 70 feet of strata above the Adkins, or Adkinson Seam No. 13, are mainly composed of thin, smooth sandstones, with occasional intervening bands of hard, sandy slates.

Above these is coal seam No. 14 of the *General Section*. It is known as the *Mace-Murphree Seam*, the *Baldwin Branch Seam* and the "*Sally Hole*" *Seam*.

This seam was first opened on the lands of Mace Murphree, in the N. E. of N. E. of S. 12, T. 13, R. 2 East, but more fully tested on both sides of the Blackburn Fork, and also at a deep hole in said fork, known as the "Sally Hole," all in section 15 of the same township. Also examined where it crosses Jourdan Creek, one mile farther east in section 14.

This seam is of but little value wherever it has yet been opened. It consists of a thin seam, or stratum, of coal at the top, then an immense bed of slate filled with fossil coal plants, with a small well-defined seam of coal, and under clay at the base.

There is more carbonaceous matter scattered through the great included mass of slates than would have been required to form a thick seam of coal. In this respect it resembles the Murray Seam No. 9, where that was first opened; but differs from that in having a much greater thickness of included fossiliferous slates. A clear idea of its structure will be obtained from the following

SECTION;

Cap rock, heavy, solid.....	10 feet to 15 feet
Slate roof.....	4 feet to 6 feet
COAL.....	3 inches to 1 foot
<i>Fossiliferous slate</i>	20 feet to 30 feet
COAL.....	9 inches to 1 foot
<i>Under clay</i>	2 feet
Bed rock.	

This seam is very peculiar in the large space it occupies—upwards of 30 feet from *bed rock* to *cap rock*. No other seam, except the Murray, has been found to approximate it, anywhere, at least in this field. Its existing conditions were evidently produced by the infiltration of sedimentary matter among the coal or peat-making plants, during the ages of

their growth, which prevented their being consolidated into one body. That the same conditions, for an indefinite period of time, should have extended over the whole of this coal field, would seem to be exceedingly improbable. Hence the expectation may be reasonably indulged, that somewhere in this field, not yet discovered, the ample carbonaceous matter of this seam may be found in one large compact coal seam.

The great thickening of the Murray Seam, under like conditions, towards the northeast somewhat strengthens and confirms this expectation.

The *Farley Seam* No. 15 of the GENERAL SECTION lies about 140 feet above the big fossiliferous seam. Strata mainly thin slaty sandrock. Coal seam opened many years ago on the Farley branch. Coal good, but too thin to be mined.

There is probably another seam lying between the two last mentioned, but if so, it is also a thin one.

Between seams Nos. 14 to 20 there are about 500 feet of strata of very similar structure, mainly thin slaty sandstone, and beds of thin sandy slate, and holding many thin seams of coal. Each of these seams is capped by a harder and more compact ledge of sandstone. These ledges of cap rock very plainly mark the position of the several seams in this thin seam belt. Neither of these six seams was anywhere found to be thick enough for mining, and they are hence regarded as of but little value.

Probably the best one of this thin seam series is the upper one, No. 20 of the *General Section*. It carries throughout very good to excellent coal, and has been much sought after for blacksmiths' use. In the low grounds and along the streams in sections 16, 17, 18 and 20 of T. 13 R. 2 E. it has been obtained by stripping off the thin overlying strata. The seam here is seldom over a foot thick, often less, and overlaid by 6 to 8 feet of very fossiliferous shale. The fossils in this slate are numerous, distinct, and often of large size. They mark the horizon of the seam so well that it is

readily located by the exposed fossils. It was hence called the *Guide seam*, because it was a well known landmark, and aided in assigning other seams to their proper horizons. This seam is lost sight of in the divide between the two main basins of this field, but makes its appearance again in the Locust Fork basin. A good deal of coal has been taken from it in sections 19 and 20 of T. 12, Range 3 E. The coal is equally as good as in the Blackburn River basin, and a little thicker—12 to 14 inches thick. The overlying fossil-filled shale is replaced by about the same thickness of fossil-filled dark *fissile slate*. This is the only seam that is known to carry this kind of slate. It mines up in large square blocks, like roofing slate, and splits smoothly one way. Wherever split there is at least one beautiful impression of a fern leaf, or frond, on one or both sides of the slate.

This seam was also seen on the bottom lands of Dry Creek in S. 19, T. 11, of R. 4 E. about three miles east of Walnut Grove. Slate fissile, and full of fossil leaf-impressions. This coal seam was stripped and raised from the bed by *Warren Haynes*, occasionally, for many years. It is not worked now, but is widely known as the *Haynes bed*. This seam was only seen at these two places in the Locust Fork basin. The position of the Haynes bed is close to the elevated southeastern margin of Bristow's Cove—the continuation and representative of Straight Mountain—with the trend of the seam closing in toward that uplift.

This condition is due to the fact that above, or northeast of, the Locust Fork of the Warrior River, the trend of the Cove is *east* of northeast, and that in the course of about twelve miles, this eastward trend has cut into the Blount Mountain Coal Field about one and a half miles. Hence all of the coal seams near its northwestern side are cut by the edge of the cove at an acute angle, and end or terminate in that uplift, which makes the southeastern rim of the cove. Hence this seam cannot be found any farther toward the northeast. This opening was made on its southeastern outcrop, and at or near its most northeastern extension.

This coal was analyzed by Dr. J. M. Pickel, of the University of Alabama, with the following result:

ANALYSIS OF COAL—HAYNES SEAM.

Moisture.....	1.27
Volatile combustible matter.....	36.49
Fixed carbon.....	56.19
Ash	6.05
	<hr/>
	100.00

Coke	62.24
Sulphur	3.87

Above the Guide Seam No. 20 the strata are generally clay slate and thin sandstone; in some places wholly clay slate; in others, mainly hard slate and sandstone for fifty to sixty feet, to seam 21.

The *Armstrong Seam*, No. 21, of the *General Section*, was first opened on Armstrong's Creek, in S. 17, T. 13, R. 2 E., by W. B. Armstrong, about sixty feet above seam 20. The cap-rock over this seam is very massive, but not in all places solid rock. Generally it is a rock that weathers into a rough scaly mass, giving it the appearance of compacted shale. In other places the rock is solid and smooth in its lower portion, and only scaly and scragly in its upper parts, yet always presenting a type, or idiosyncrasy of structure that could be very readily recognized, and the seam traced without difficulty. It extends throughout the upper half of the Blackburn Fork basin, and is found in the Locust Fork basin, and probably extends through the divide between them. Towards the western end of the Blackburn Fork basin, this seam either becomes small and insignificant or is divided into two seams. Near the western side of S. 20, T. 13, R. 2 E., the characteristic cap-rock of this seam is found about 40 feet above Seam No. No. 20, with a thin six inch seam of poor coal beneath it. This is at least 20 feet below

its normal position, and more than 80 feet below the Woodward Seam next above it, yet no evidence of an intervening seam was found between them, where the upper member of the Armstrong Seam properly belonged. It is probable that this seam either divides or terminates near this place. It was not traced or recognized southwest of the range line between ranges 1 and 2 east.

To the northeast of S. 20, T. 13 of R. 2 E., its position is very plainly indicated by its very prominent cap-rock, through the remainder of this basin till it passes beneath the divide between this and the Locust Fork basin. Its cap-rock is again seen in S. 20, T. 12, R. 3 E., near the Locust Fork, and finally on the edge of Dry Creek, in S. 19, T. 11, R. 4 E., at the very edge of the uplift that makes the rim of Bristow's Cove. It is here about 40 feet above the guide seam, or *Warren Haynes' Seam* last described. It may be of workable thickness here, though its outcrop showed only 18 inches of coal.

Where first opened in the N. E. $\frac{1}{4}$ of S. 17, T. 13, R. 2 E., this seam presented the following

SECTION:

Cap-rock, hard, solid, shaly on surface.....	15 feet.
Roof, bluish slate, and reddish shale.....	4 feet.
COAL.....	4 inches.
Slate and black band.....	6 inches.
COAL.....	7 inches.
Clay.....	7 inches.
Coal.....	8 inches.
Slate and pyrite.....	2 inches.
Coal.....	6 inches.
Under clay.....	-----.

Whole thickness of seam here 40 inches, exclusive of roofing-slate, and under clay—ample thickness for mining, but there were too many partings, and the character of the coal was not satisfactory.

Another opening was made in this seam in the S. W. $\frac{1}{4}$ of the same section which gave better results—seam thinner at out-crop, but carrying much better coal.

This opening gave the following

SECTION:

Cap-rock solid, upper part shaly.....	15 feet.
Roof, light-blue slate.....	4 feet.
COAL, good, bright.....	3 inches.
Slate and blackband.....	6 inches.
COAL, good.....	6 inches.
Clay, dark-gray.....	7 inches.
COAL, good, clean.....	8 inches.
Slate.....	1 $\frac{1}{2}$ inches.
COAL.....	2 $\frac{1}{2}$ inches.
Under clay.....	— — — — —

While this opening gave but 34 inches at the edge of the cap-rock, yet the seam thickened one inch per foot as far as the entrance was made. This increase in thickness gave assurance that the seam was thick enough for easy mining; dip south by east 4 deg.; above water-level, self-draining. The coal was found to be a good shop coal, coking well, and holding but little sulphur.

Its analysis by Dr. J. M. Pickel is as follows:

ANALYSIS OF COAL—ARMSTRONG SEAM.

Moisture.....	1.46
Volatile combustible matter.....	31.11
Fixed carbon.....	64.97
Ash.....	1.46
	<hr/>
	100.00
Coke.....	66.43
Sulphur.....	3.87

This is an excellent seam of coal of the very best quality and giving an exceedingly small percentage of ash.

Above the cap-rock of the Armstrong Seam the strata are hard arenaceous shale and hard flaggy sand rocks, increasing in hardness and thickness to the bed rock of the Woodward Seam, which is a solid, compact, yellowish-gray sand rock 2 to 3 feet thick.

The whole thickness of intervening strata, between the Armstrong and Woodward seams is forty to sixty feet.

The Woodward Seam No. 22 of the *General Section* has been cut in many places in sections 18 and 19 of T. 13, R. 2 E. An opening was made on this seam in the S. W. of the N. E. of s—d S. 19 with the following results: Seam penetrated about four feet, when work was stopped by wet weather, and the caving in of the cut. The seam at the end of the cut presented the following

SECTION:

<i>Roof</i> , soft slate.	
COAL, cubical.....	9 inches
Slate parting, probably local.....	$\frac{1}{2}$ inch
COAL, good.....	10 inches
Clay parting.....	3 inches
COAL, bright, hard.....	16 $\frac{1}{4}$ inches
Under clay.	

Whole thickness of seam 39 inches; the seam thickening and the quality of the coal improving as the work progressed. A sample of the coal last taken out upon analysis by Dr. J. M. Pickel yielded the following result:

ANALYSIS OF COAL—WOODWARD SEAM.

Moisture.....	1.17
Volatile combustible matter.....	34.90
Fixed carbon.....	59.52
Ash	4.41
	<hr/>
	100.00
Coke	63.93
Sulphur.....	2.20

This seam as observed at many other places is always in two benches. It has always a clay parting near the middle of the seam. The small slate parting in the upper bench in section 19 was not seen at any other place. It was hence inferred that it was only a local peculiarity, and would not continue far. The seam may therefore be considered as a two-bench seam, carrying 16 to 18 inches of coal each, and separated by 3 to 4 inches of clay, which is easily removed and will much facilitate the operation of mining and working this seam.

This coal has a fine reputation as a good shop coal. It cokes well and easily, is low in sulphur, and possesses a large amount of fixed carbon, giving it free combustion and endurance in the furnace.

At some places where this seam has been opened the upper bench has been found too bony for good blacksmith coal, and better suited for grate coal, yet this peculiarity is also local and does not obtain universally. Where this seam was opened by the Survey there was very little difference in the grade or quality of the coal in the two benches of the seam, the upper one being just a little more splintery, and mining out in larger blocks than the lower one was the only observable difference.

This is doubtless a fine seam of coal, thick enough for mining, and occupying a position in the field high above water level, and lying throughout its extent almost horizontal, will give all desirable facilities for easy mining.

The Woodward Seam is the upper one over a large extent of this field. It may be regarded as the top seam of the Blackburn River basin, so far as it extends. It is found on all the high lands to the north and northwest of the Blackburn Fork. It may extend through the divide between the two basins, but has not been seen or recognized in the Locust Fork basin. It probably exists there also, but is thinner and less prominent than in the Blackburn River basin.

Above the Woodward Seam the strata are mainly fine ar-

gillaceous shale of varying thickness, according to the elevation of the country, from 40 to 125 feet.

These strata are easily eroded and have been much gullied and excavated, and now present a surface of level plateau flanked by steep-sided ravines and gorges, and long, dry hollows and low ridges.

Near the divide between the two basins there has been less erosion, and the country is in the main an undulating plain, only broken by the small streams which make the headwaters of the two forks of the Warrior River. On this high plateau there is no well marked top of the water shed, but streams are found interlocked and flowing in opposite or diverse directions into the Calvert Fork, the Blackburn Fork and the Locust Fork of the Warrior River.

On the northwestern side of the Field, near the top of the divide in S. 26, T. 12, R. 2 East, near the Tait Gap, in Straight Mountain, the surface becomes more elevated towards the northeast, and a higher series of coal measures exists. These upper measures increase in thickness and elevation for two miles in a northeasterly direction, attaining their maximum elevation in sections 17 and 19 of T. 12, R. 3 E., but continuing to, and across, the Locust Fork of the Warrior River.

In this space it must also be noticed that the measures decline or sink towards the basin of the Locust Fork, and hence the upper measures have a greater thickness here than is apparent from the elevation of the country. It has not been found practicable to get an accurate measurement of the amount of this declination of the measures towards the Locust Fork. Yet it is very perceptible on both sides of the river. The depression appears to centre, or be the greatest, at, or near, where the river passes out of this Coal Field. This roll or depression may not much exceed a hundred feet. It cannot be less than that and certainly cannot exceed two hundred feet.

But it is enough to put the lowest seam of the upper measures below water level at its southeastern outcrop, its

highest point. *Water level*, however, is always a relative term, dependent on the natural drainage of the locality. Yet the base of these upper measures here is so near the level of the river that it is apparent that they are absolutely lower by from one to two hundred feet than they were a few miles to the southwest.

The lowest seam of this upper series of measures is No. 24 of the *General Section*, a very fine seam of excellent coal. It was opened near its southeastern outcrop, on the headwaters of Pouch Creek, by Mr. Phillips, and is known as the *Phillips Coal Bed*. The opening is in S. 19, T. 12, R. 3 East, about 50 yards east of the range line, and within a 100 yards of the southwest corner of the section.

The coal was reached by stripping off the surface clays, three to six feet thick. No cap rock or roofing slates above the coal at this point. Coal of good quality, in one solid bed, 3 feet 2 inches thick. The works were filled up when examined and a section of the bed could not be obtained. The dip of this seam at this place is 10° to southwest, this is doubtless due to some local roll in the measures. A quarter of a mile to the northwest, where the rocks are well exposed, the dip is very regular, about 8° to northwest.

This seam of coal could be drained and mined at this place, and when cut into beneath a solid roof would doubtless yield a still better quality of coal, with a probably increased thickness of seam. A short distance from the opening the edge of the cap-rock of this seam crops out, but its thickness could not be ascertained.

The rocks above and around this seam are all quartzitic, composed of distinct and well rounded grains of quartz. All of them show the saccharine or sugar-loaf texture; while some have the fish-roë, or öolitic texture. This peculiar lithological structure extends from a little below this seam, with slight variations to the very top of the measures. Hence this upper group of coal seams may be properly designated as the quartzitic, or upper conglomerate group.

This is a very interesting and valuable group of coal

seams. It does not cover a large extent of country, but holds throughout its extent *three* very fine seams of coal, besides several smaller ones in a vertical thickness of one hundred and eighty-five feet.

The only other opening beside the Phillips yet made on the lower seam of this group, is about a mile north of the Phillips bed, and on the opposite side of a high ridge in the S. E. of N. E. of S. 18, T. 12, R. 3 E. This opening was made many years ago, and coal taken out from time to time by many different parties. The opening is locally known as the *Lower Baine bed*. The opening was made by sinking a pit in a flat hollow, near the side of a branch, and below water level.

Many statements, probably exaggerated, were made about the thickness of this seam by the parties who had dug coal here. They generally agreed that "the seam was over 6 feet thick." Others said "the seam was standing on edge, and was more than 6 feet across." These statements were made by men of average intelligence and unquestioned veracity. To settle the uncertainties about the size, structure and identity of this seam, it was determined to clear the pit of water if possible, so that the seam could be seen and examined. With the aid of several hands, and after long and persistent labor, this was accomplished.

The seam was found to occupy a normal position—dip 6 deg. east, and gave about the following

SECTION:

Blue shaly clay and thin coal seams.....	2 feet
COAL, solid, face and butt structure.....	3 feet 4 inches
<i>Clay</i> , apparently under clay.	

It is not absolutely certain that the clay beneath this coal is *under clay*; it may be a clay parting in the seam. The inflow of water was too great to admit of testing any deeper. It can only be positively stated that it had the appearance of *under clay*.

This coal is of very fine quality, and the seam is evidently one of great value. Though the seam where opened is below the water level, except in very dry weather, yet there is fall enough that could be used, without heavy expense, to make a large portion of this seam self-draining.

An average sample of this coal analyzed by Dr. J. M. Pickel gave the following results:

ANALYSIS OF COAL—BAINE BED.

Moisture.....	1.18
Volatile combustible matter.....	32.35
Fixed carbon.....	64.18
Ash.....	2.29
	<hr/>
	100.00 •
Coke.....	66.47
Sulphur.....	0.92

This is a very remarkable seam of coal—practically it carries no sulphur. It will be largely utilized in the future for smelting iron and furnace work. That this opening and that of the Phillips bed are both on the same seam was very satisfactorily settled by their relative dips, their equal distance above the slate beds, and their environment by the same peculiar class of rocks. All these points of agreement left no room to doubt their identity. The Baine opening shows two inches more coal, and of better quality than the Phillips bed, but these differences probably arise from its better protection; and at neither place is the seam well enough protected to have preserved its full normal thickness, or its best coal.

This seam, lying as it does at the base of the quartzitic group, is necessarily more extensive than those above it. And though it has not been opened at any other place, yet this is probably due altogether to the fact that its position has not heretofore been recognized, and the seam searched for. Lying as it does near the base of the ridges, with its

out-crop often hidden by the debris of the higher lands, it is no wonder that it has been overlooked, especially since it was in a position where no seam of coal was expected to be found or known to exist.

It may be confidently looked for above the slates and near the base of the quartzites, on both sides of the high ridge which rises between the head waters of Ponch Creek and the Drury Bynum Creek in S. 19, T. 12, R. 3 E., and extending to the Locust Fork of the Warrior, and also for a mile or more northeast of that stream.

Its position may also be approximately found from its relation to the well known *Carnes*, *Paine* and *Smith* seam, which lies about 60 feet above it, and is well marked by a heavy, massive cap-rock that generally shows its position.

The *Carnes*, *Smith*, *Paine* seam, No. 25 of the GENERAL SECTION.

This seam is better known than any other in this coal field. It is the only one on which coal mining to supply the market has successfully been carried on. A tunnel was driven in on this seam in S. E. of S. 8, T. 12, R. 3 E. by G. B. Carnes, who supplied the local demand for coal for several years. Since then other openings have been made on the seam by *Smith*, *Gaither*, *Paine* and others. The coal is uniformly good, coking well and working well in the forge. We have no analysis of the coal of this seam, but in all practical tests to which it has been subjected it has given satisfaction.

The best exposure of this seam that was examined is in the S. W. of N. E. of S. 18, T. 12, R. 3 E. It there presented about the following

SECTION:

Shale and thin soft sandstones.....	10 feet
Cap rock hard, quartzitic, wavy.....	3 to 8 feet
Blue slate roof.....	3 to 4 feet
COAL, hard, bright, cubical.....	3 feet 8 inches
<i>Under clay</i> , fine, dark.....	3 feet
Dip of strata, 25 degrees to southeast.	

This high dip evidently does not continue far in that direction. In the S. E. of N. E. of same section, about one-fourth of a mile east from this opening, and at several other places the southeast dip is 3 degrees to 5 degrees. It probably diminishes to about that declination within a hundred yards to the southeast of this opening.

In the southwest $\frac{1}{4}$ of section 8, same township, an opening was made on this seam by Mr. Samuel Smith, but a tunnel was not driven in on the seam. This opening exposed the following

SECTION:

Cap rock, coarse-grained sand rock	15 feet
Roof, reddish clay slate	8 feet
COAL, good, nearly	4 feet
Under clay.	
Dip southeast, 3 degrees.	

CARNES' COAL MINE.

Half a mile farther to the east in southeast $\frac{1}{4}$ of the same section, is the *Carnes* opening and tunnel, on the same seam. Coal, 3 feet 8 inches, solid, good quality. Cap rock and roof similar to the above section. By aneroid measure the Carnes mine is 75 feet higher than the Smith opening, but the dip of the strata is here 5 deg. west, showing a local elevation or roll in the strata. The direction of the dip will fully account for the difference in elevation, while the similarity of the coal and all the enclosing strata fully proved the identity of the coal seams at the two places.

THE GAITHER OPENING.

An opening on this seam has been made by Mr. Gaither in the northeast corner of S. 10, T. 12, R. 3 East. Coal covered up when visited said to be 4 feet thick. A wide opening had been made here, and the bluff cut into the solid rock, but no tunneling done. The coal is said to be of very good quality, but when visited could not be seen, being buried by

slides from the top of the cut. Dip of strata here 5 deg. to northwest.

About half a mile to the northwest of the Gaither opening, and on the northwest side of the same ridge, Mr. Gaither had cut a coal seam 3 feet thick which lies 20 feet lower by aneroid measure.

It was supposed that both openings were upon the same seam of coal. There is much room to doubt the correctness of this supposition; the dip of 5 degrees would, in half a mile, carry the seam first opened, much more than 20 feet below its level at the opening in section ten (10), and the associated rocks at the second opening do not add anything to sustain the claim of identity. It is probable that the second opening here on the N. W. $\frac{1}{4}$ of S. E. $\frac{1}{4}$ of S. 4, T. 12, R. 3 East is on a coal seam not yet named or identified which lies between this seam and the Bynum Seam, and which is numbered 26 in the General Section.

The *Carnes-Gaither* Seam No. 25 has also been opened and mined by *James Smith* on the bluff of the Locust Fork, near the southeast corner of S. 2 in T. 12, R. 3 E. The coal has a fine reputation, and there is a ready home market for all that has yet been mined here. When visited, mining had been for some time suspended and the drifts so blocked up that measurements of the seam could not be made. The seam is well known to carry good coal throughout, to be solid, and upwards of three feet thick.

By aneroid measurement it was found that the seam here is 70 feet lower than at the Gaither opening in the northeast corner of section 10, showing the downward flexure of the measures towards the Locust Fork of the Warrior, heretofore noticed.

Northwest from the James Smith mine on the opposite, or northwestern side of the same ridge, this seam was also opened on the lands of *Mr. Zach. Paine*, near the line between sections 2 and 3 of the same township. Coal same as at the other openings. Seam between three and four feet thick.

This seam has also been cut by James Smith on the hills or river bluff, northeast of the Locust Fork, but the prospect was not so good as on the southwest side of the river. Probably the seam becomes thinner northeast of the river. The hill or high ridge which contains this seam does not extend far in that direction. One mile northeast of the river it becomes broken up into knobs, and these soon become less and less prominent, until they sink into an undulating plateau, which does not contain any of the coal seams of the quartzitic group.

The downward flexure of the coal measures, in this basin, has its greatest depression at, or near, the Locust Fork of the Warrior, in a southeast and northwest direction; and northeast of the river the measures are gradually elevated till they attain their normal level. The lower coal seams of this group must necessarily come to the surface within one or two miles northeast of the river. The measures here contain much less rock and hard strata than exists southwest of the river, and are more abraded. The outcroppings of the seams have not been discovered; there are no rocky ledges to designate their positions, and it is very probable that they very materially thin out towards the northeastern end.

Number 26 of the *General Section* is a seam that as yet has received no distinctive name, and about which but little is known.

It lies immediate between the *Upper Baine, Carnes Seam* No. 25, and the *Bynum Seam* No. 27 of the *General Section*.

Some prospector first cut this seam in a pit on the north side of the long high ridge which holds the quartzitic group of coal seams, in the S. E. of N. E. of S. 18, T. 12, R. 3 E. Its position is about 40 feet above the *Upper Baine, Carnes* seam, and probably about the same distance below the *Bynum Seam*. The pit was not cut far enough into the hill to reach or expose any cap rock, or probably to show the full thickness of the seam.

The roof was shale. The seam had increased from 8

inches at the outcrop to 20 inches at the end of the pit, a distance of say 6 feet, or about 2 inches to the foot. The coal appeared to be of good quality, and may yet ~~prove~~ be thick enough to be valuable. The outcrop of this seam was noticed in many places along the face of the ridge, but is not known to have been cut at any other place, unless the opening made by *Mr. G. F. Gaither* in section 4 of this township, heretofore alluded to, is on this seam. That it is, seems very probable.

Its position and surroundings correspond better with this seam than any other. The difference in the thickness of the seam at the two openings, one 20 the other 36 inches, may be altogether due to the depth to which the respective openings have been cut into the seam.

Neither of them had penetrated far enough into the hill to make a fair and satisfactory test—the capping rock and roofing slates were not reached—only enough exposure was made to render it reasonably certain that this is an important and valuable seam of coal.

THE *Bynum* Seam No. 27 OF THE *General* Section.

This coal seam was opened by *Elijah Bynum*, near the middle of S. 17, T. 12, R. 3 E., on the southeast side of the quartzitic ridge. This seam is about 180 feet above the *Phillips* or *Lower Baine* Seam, and just above the fourth conglomerate rock, some of the pebbles of this rock are found in connection with the seam. It has as yet been only partially opened, and accurate measurements could not be made, but it shows approximately the following

SECTION :

Shale and soft sand rock	20 feet
Roof, blue slate	4 feet
COAL, very good	4 feet 4 inches
Under clay	3 feet
Soft sand rock and conglomerate	30 feet

When examined, the opening or pit was partly filled up, and only the upper part of the coal seam was visible. It was described by the man who opened it, as having a 2-inch slate parting near the bottom; approximately the seam carries about the following

SECTION:

<i>Coal</i> , solid, good.....	36 inches
Slate parting.....	2 inches
<i>Coal</i> , solid, good.....	14 inches

Thickness of coal at outcrop, 50 inches.

There is good reason to anticipate an increase in the thickness of this seam when cut in beneath a solid roof. It would require a further cutting of ten feet at this place to get under a solid cap rock. Until that is done, a fair exposure of the size of the seam, or of the quality of the coal it carries, cannot be obtained.

This coal has been freely tested in blacksmith forges, and is commended as a good shop coal. The seam is evidently one of the best in this coal field; probably carrying a thicker body of solid coal than any other yet discovered.

But unfortunately this seam is of but very limited extent. So far as yet known it only underlies portions of sections 17, 18 and 19 of T. 12, R. 3 East. Possibly a little of this seam may exist in section 9 of this township, though its outcrop was not seen there, and this opinion is based solely on the fact that a portion of that section is apparently high enough to contain it.

The space which this seam is certainly known to underlie is about 700 acres. But small as this area is, should the seam only hold the thickness it shows at the outcrop, it contains over 5,000,000 tons of coal.

The strata in the ridge containing this seam are nearly horizontal. This ridge stands just where the northwest dips of Blount Mountain meet the southeast dips from Straight Mountain, both gradually declining into the horizontal

Coal mining could be cheaply done here. Self draining tunnels could be driven into this seam on either side of the ridge, at any desired point, thus avoiding the usual heavy expense of pumping water and hoisting coal.

The outcrop of this seam was traced from the Bynum opening in section 17 toward the southwest. It shows very plainly in places around the irregularities of the ridge to the southeast $\frac{1}{4}$ of section 18, where is found the southwestern outcropping of the *fourth conglomerate*. About 10 feet above this rock and little farther to the northeast is the outcrop of the Bynum Coal Seam, its farthest southwestern margin. From this point toward the northeast the ridge rises about 50 feet higher than the outcrop of this seam for a half mile, thence for the like distance is a further rise 25 to 50 feet. On the northwest side of this ridge the outcrop of this seam is generally very plainly discernable, just above the upper edge of the decomposed conglomerate. It is not marked by any bold outcropping cap rock, as most coal seams are marked. The cap rock of this is evidently soft friable coarse sandrock, which only occasionally shows on the surface at all, and never prominently.

Towards the northeast corner of section 17 the ridge becomes very narrow, and it is cut by a gap in the southwestern $\frac{1}{4}$ of section 9, called the Hayse Gap, in which the strata is abraded down below the fourth conglomerate. No evidence of this seam was found any farther to the northeast, though in portions of this section (No. 9) the ridge again rises higher and the large pebbles of the fourth conglomerate are often seen in abundance, and not always on the highest ground. Some parts of the northeast $\frac{1}{4}$ of this section and of the northwest of section 10, and of the southwest of section 3 of T. 12, R. 3 E., are seemingly high enough to contain remaining detached portions of this seam. When searched for, the horizon of the underlying conglomerate pebbles will be the best guide the prospector can follow in seeking its location.

No. 28 of the *General Section*, the top seam of this coal field, has no distinctive name. Its position is about 30 feet above the *Bynum* Seam, or 35 feet above the top of the *fourth conglomerate*. It has only been dug into in one place, where it was two feet thick. This may not be average thickness for the seam. Its outcrop was seen in several places, and its position satisfactorily obtained. It does not appear to be well roofed in, and the coal is probably soft, neither does it occupy quite as much space as the *Bynum* Seam No. 27.

The measures above the *Bynum* Seam are mainly composed of irony shale and soft reddish clays, with very little rock appearing on the surface. Yet there may be in places a sufficient roof of rock, or hard slate, to give this seam the necessary protection against the disintegrating agencies of nature, and make it of some commercial value.

Above Coal Seam No. 28 there are rarely more than 20 or 30 feet of strata. The ridge which makes the top member of the measures in this field is smooth-topped, with surface gently undulating. It rises gently near the divide between the headwaters of the *Blackburn* and *Locust Forks*, and close to *Straight Mountain*, forming on its southwestern end apparently a part of that elevation, but gradually separating from it towards the northeast. Between this ridge and *Straight Mountain* rise the extreme headwaters of the *Calvert Fork* of the *Little Warrior*. This stream flows northeast between this ridge and *Straight Mountain* to about the middle of S. 8, T. 12, R. 3 E., where it has cut through the latter, and pursues its southwest by west course down *Murphree's Valley*.

This ridge begins to rise higher towards the northeast, near the Range line between Range 2 and 3 East, and its rocks begin to show a distinctly quartzitic structure. It probably attains its greatest elevation in S. 17, T. 12, R. 3 E., but there is no material diminution of its height to the *Hayse Gap* heretofore mentioned, in section 9 of this township. It is again nearly cut through in section 3, same

township, by the head stream of Whipporwill Creek, which rises near its southeastern side. Approaching the Locust Fork, its altitude is sensibly diminished by the declination of the strata in that direction; and that stream divides it near its northeastern end.

This ridge which is so prominent and important on account of the valuable coal seams it contains, is comparatively narrow, only about a mile in diameter at the base, and often less than half a mile broad at the top. It stands close to Straight Mountain for about half its length, there being a space of only from 100 to 300 yards between them, but they gradually separate and become farther apart toward its northeastern end, where they are nearly a mile apart. In other words, the northeastern end of this ridge is about one mile southeast of the vertical southeastern edge of Bristow's Cove; but there is a small vertical uplift *between them*, and within one-fourth of a mile of the base of this ridge. This vertical uplift is probably, as heretofore noticed, a branch, or fork, of the Straight Mountain uplift, which deflecting eastwards, is plainly seen extending as far as the northeastern end of this ridge, but beyond that is not perceptible on the surface.

The foregoing embraces all the observed facts and details of coal seams in this field, which may be regarded as reliable, or reasonably certain. There are other seams of coal the identity of which have not been conclusively settled, and matters of fact and observation which may be stated only hypothetically. All these are reserved for the next section.

SECTION V.

UNSETTLED QUESTIONS.

While much time and labor and study have been given to this field with a view of identifying every coal seam, and

clearly outlining its structure, yet owing to certain irregularities of level and of faulting, this has not in all cases been clearly accomplished.

The greatest difficulty in identifying seams was found along the southeastern base of Straight Mountain, where a fault of varying and uncertain depth exists. This fault partly exposes, but also dissevers the mountain from, the northwestern edge of the productive coal measures. Several important coal seams are found in close connection with this line of fault which as yet can be only doubtfully referred to their proper position in the field.

Among these doubtful seams is the *Waide seam* already described under the head of "*Explorations*" (page 23). It was doubtfully referred to No. 8 of the *General Section* under the head of *Details*. That reference was made solely on the similarity of the surroundings, the cap-rock and intervening slates, the coal seam being under deep water, and unseen. Could the coal seam have been examined at this, or other places in the river where it was presumed to come near the surface, and to be cut by the water in deep places, fuller evidence of identity would probably have been obtained. Usually the surroundings of a coal seam, the overlying slates and cap-rock, afford better evidence of identity than the size and structure of the coal seam itself. The latter may vary from place to place in quality, thickness and partings, all produced from local inflows of sediment during the period of its formation; the former resulting from a general inflow of sedimentary covering, more widespread, uniform and persistent, necessarily give characteristics of greater uniformity. From these surroundings alone, and from the further fact that no other seam of coal possessed similar surroundings in that part of the field where its outcrop must necessarily come to the surface, this one was without much doubt referred to the *Waide seam* No. 8. This would, if accepted as sufficient evidence, fix its southeastern outcrop in nearly a southeast course from the Waide Gap where it

was discovered, but does not serve to fix its position except inferentially in other parts of the field. In fact it is not yet certainly known that this seam has been seen at any other point than the Waide Gap. Yet it is very probable that at its proper horizon it is co-extensive with this coal field.

A coal seam of about 3 feet thickness exists at the *Allgood Gap*, in S. 4, T. 13, R. 2 E., in connection with a large body of slates, which may possibly be this seam. But it is among the vertical measures, with no cap-rock or other surroundings to afford it identification. Should this be the *Waide seam* it is evident that its normal place is far beneath the surface, and can only be reached by deep mining. In the other gaps through Straight Mountain, between this one and the Locust Fork, its position is still deeper, and it is not brought to the surface by the vertical uplift. Its southeastern out-crop in the middle of the field is necessarily in the high lands which make the divide between the two branches of the Warrior, where all out-crops are so thoroughly covered up that no coal has yet been discovered.

The Cowden Seam—not classed and probably not included in the *General Section*—presents another case of unsettled identity. This seam, of which a description and sections are given under the heading of "*Explorations*," was one of the first coal seams opened in this field. It was opened the first year of Prof. M. TUOMEY's service as *State Geologist of Alabama*, under the direction of *George Powel* one of his assistants. The opening on it was made by John P. Cowden, who had discovered it, and is hence called "*the Cowden Seam*."

The assistant reported the seam as being 4 feet 10 inches thick, and Prof. Tuomey paid Mr. Cowden a premium of \$10.00 for its discovery.

The first opening on this seam may have been made where it was abnormally thick; subsequent openings near the same place show a seam of 4 feet 2 inches thick, including a parting of 4 inches of soft slate, dividing the coal into two

benches; about two-thirds of it above the parting, and one-third below.

Other openings made presumably on the same seam, in gaps through Straight Mountain, yet farther to the southwest, show a still thicker parting with slightly less coal.

The character of this coal where first opened is peculiar. It is massive, rather dull in color, cokes imperfectly, and yields a rather copious red ash. Farther to the southwest the quality of the coal is somewhat improved, but yet it retains all of its distinctive features.

The unsettled questions about this seam are, what is its true position in this field, and what relation does it bear to the other seams? These questions being unsettled, it is not included *by name* in the GENERAL SECTION of this field, though it may be included *in fact*.

That *section* was constructed by *measuring across all the known out-crops of seams*, on the longest slope of the field, from southeast to northwest. If it is *not included* in that *section*, then its southeastern outcrop has not yet been discovered, and it must be in one of those wide spaces of measures which have hitherto seemed barren of coal. If it is *included*, then the character and appearance of the seam, and the quality of its coal, are materially different at its southeastern and northwestern out-crops. One or the other of these propositions is apparently true.

Of the first proposition, it may be said that it seems improbable that in the many streams descending from the top of Blount Mountain toward the river, a coal seam of the size of this one should not have been cut and exposed, if it existed in that space. And yet coal seams undiscovered may exist, as has been heretofore suggested, in that wide space that exists between Nos. 3 and 4, and also between Nos. 4 and 5 of the General Section.

That the Cowden Seam could not crop out between seams 3 and 4 may be considered demonstrated by its greater distance than No. 4, above the second conglomerate. Seam No. 4 is about 300 feet above that conglomerate, while this seam is over 600 feet above that rock, as shown by the ex-

posed strata, beside the unknown amount of fault or upward sliding of the vertical rocks, between it and the conglomerate, as exposed in Straight Mountain. If no fault or upward thrust of the strata existed here the measurements would make the Cowden approximately coincide with the *Sand Creek* No. 1, No. 5 of the *General Section*, and the coals of these seams bear a close resemblance to each other. But the seams do not correspond in thickness, nor in the general character of their surroundings, so far as these could be seen on Sand Creek.

We must moreover consider the probable amount of upward thrust of the vertical rocks of Straight Mountain, which certainly cannot be less than the whole height of the mountain—from 300 to 400 feet—or at the lowest estimate, than the difference between the height of the top of the mountain and the general level of the adjacent coal measures. This would give an apparent depression, by so much, to the measures, as compared to the Straight Mountain rocks, hence they appear in this section *below* their normal place in the field. Taking this fact in connection with the measurements made, it becomes evident that the southeastern outcrop of this seam must be looked for higher up in measures than the upper Sand Creek Seam, and that its probable position southeast of the Cowden opening will be at, or near, the Blackburn Fork of the Little Warrior.

This portion of the field contains many coal seams, and of these Nos. 7 to 14 inclusive of the *General Section* have been cut by that little river, yet none of these carry similar coal, or have the appearance of the Cowden Seam. And there seems to be none there yet undiscovered.

Apparently the solution of the difficulty must be found in the other proposition, that some one of the seams already known has changed in character and quality of its coal, between its southeastern and northwestern outcrops. Which one is it? The answer can only be given hypothetically. The seam that from its position and general make-up would appear the most probable one, is the *Big Holt Seam* No. 7 of the *General Section*.

The Holt Seam carries about 4 feet of coal and nearly 2 feet of black band, but with an aggregate of over 5 feet of foreign matter. This foreign matter, clay, slate and rock, were probably *local inflows* of sediment during its formation, and hence not co-extensive with the seam. It is from this cause that partings in coal seams are produced, and they are for the same reason subject to great and frequent variations in thickness, often terminating altogether.

This *Holt* or *Big Seam* is probably the equivalent or counterpart of the "MAMMOTH SEAM" of the *Cahaba Coal Field*, which shows unusual variations in its splits and partings. Both occupy about the same position in the coal measures, both are about the same size, over 12 feet from roof to under clay, both have rocky parting near the middle. The Mammoth Seam splits into two seams toward the south, may not this also split toward the northwest? Or may not the partings diminish in that direction and all but one disappear as it is in the Cowden Seam? These queries can only be answered satisfactorily by future extensive explorations and practical mining operations.

A coal mine is now being opened on this seam in S. 4, T. 14, R. 1 E., near the bank of the Blackburn Fork, about one-fourth of a mile above the railroad bridge, which, in its progress, may throw additional light on the relations of this very interesting seam of coal. At this opening its position is about 15 feet above the bed of the river, with a dip of 3 deg. to the southeast; this dip in one-fourth of a mile will put it below the bed of the river which here flows northwest with a fall of 10 to 15 feet to the mile. The tunnelling of this seam for any considerable distance will afford data for calculating its range, dip and southeastern outcrop.

The seam known in the Cahaba Coal Field as the *Brock Seam*, lying just above the first or *Lower Conglomerate*, has not been opened or cut anywhere in this coal field, yet its existence is plainly indicated at many places by fossil coal plant impressions in the rocks at this horizon. And it was seen, and had been dug into, yet farther to the east, near

the top of Chandler's Mountain, lying above and close to the Lower Conglomerate or Millstone Grit rock. Its thickness here was less than one foot, and it is probably a thin seam all over this field. From the fact that it was not cut or opened, it was not embraced in the General Section and is only referred to now to show the persistency of the seam, and as further evidence of the close relation in structure which obtains in different parts of the Alabama Coal Fields.

The quantity of available coal in this field is another of the unsettled questions. It has been clearly shown in the *Section on Details* and by the *General Section* of the field, that there are *eleven* (11), possibly twelve (12), coal seams in this field that are over *three* (3) *feet thick*. Ample thickness for advantageous mining. The uncertainty as to whether there are 11 or 12 of these arises from the uncertainty in the identification of the southeastern outcrops of the Waide and Cowden seams. Now it would have been an easy matter to estimate approximately the area of each of these coal seams, and to calculate and aggregate their solid contents. Yet all this would have served no practical purpose, and would have been wholly hypothetical.

It would have been based on the supposition that these seams had been cut and measured where they were of average thickness, and that they all maintained that thickness all over their respective areas. This would be highly improbable. No reliance could be placed even on the approximate correctness of calculations based on such uncertain data. They might greatly exceed or fall far below the actual amount. It is sufficiently shown in this report that there is in this field ample coal for *all mining purposes and for all coming time*.

Much of this coal was discovered and exposed by the Alabama Geological Survey, especially in the years 1891-92. It was the general expression of the citizens of that section of the country "that more coal had been developed in one season by the Geological Survey than had been done by all

preceding prospectors." For the first time the coal seams were traced out and their relations shown.

Now, with the limited means and time of the survey devoted to this work, it is not probable that a full development of any one of the coal seams was obtained. Work had to be stopped on every opening before the full thickness or best quality of the coal had been reached. Only in one or two openings was any penetration made beneath the cap rock, and in every instance the coal seam was sensibly thickening when the work was stopped. Hence any estimate based on the measurements of seams thus obtained would necessarily be too low. Nothing but practical mining on each one of its important coal seams will disclose the full value and importance of this coal field.

It is shown that the productive measures at the thickest part of this field have a volume of over 3,400 feet, and that the sub-conglomerate measures have a thickness of at least 800 feet, making the whole thickness of this coal formation over 4,200. It must, however, be understood that this immense thickness of coal measures is to be found only adjacent to the Straight Mountain.

This part of the coal field is an unsymmetrical synclinal basin with its axis close to its northwestern edge, hence the deepest part of the measures lie adjacent to the mountain above named, and they thin out gradually towards the southeast, or towards the top of Blount Mountain overlooking the great Coosa Valley.

Only the great industrial developments of the future will fully expose this important coal field.

SUMMARY OF CHEMICAL ANALYSES.

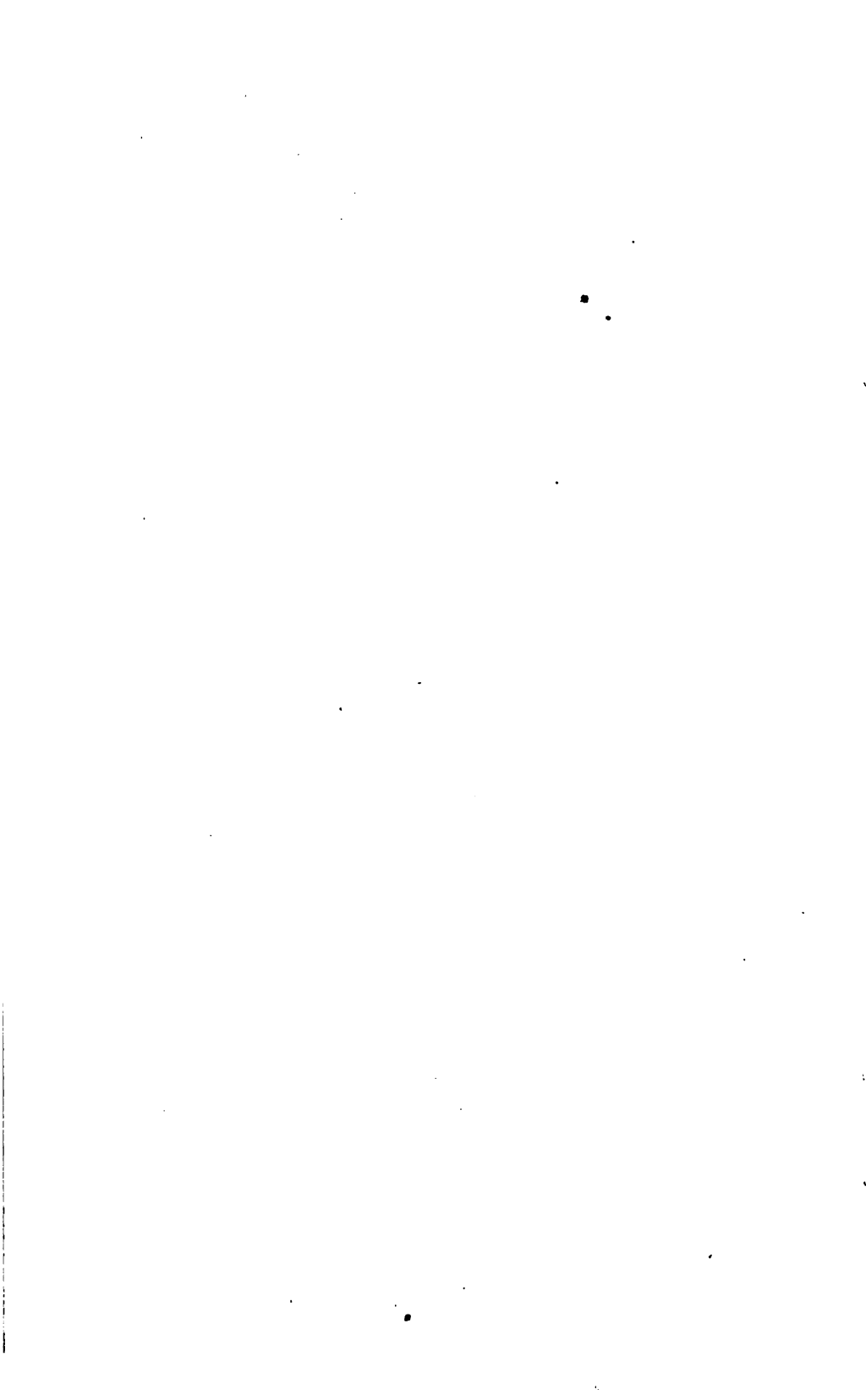
—♦—
 BY DR. J. M. PICKEL, UNIVERSITY OF ALABAMA.
 —♦—

COALS.

NUMBER.	1	2	3	4	5
Moisture.....	1.49	1.27	1.46	1.17	1.18
Volatile combustible matter.....	32.38	36.49	32.11	34.90	32.35
Fixed carbon.....	61.46	56.19	64.97	59.52	64.18
Ash.....	4.67	6.05	1.46	4.41	2.29
	100	100	100	100	100
Coke.....	66.13	62.24	66.43	63.93	66.47
Sulphur.....	1.79	3.87	3.87	2.20	0.92

- No. 1. Peacock Seam.
 No. 2. Haynes Seam.
 No. 3. Armstrong Seam.
 No. 4. Woodward Seam.
 No. 5. Baine Seam.

[THE END.]



INDEX.

	PAGES.
Aderholt Seam.....	30, 36, 37
Adkins Seam.....	49, 45, 46
Allgood Gap.....	11, 24, 69
Analysis of Coals.....	32, 50, 52, 53, 58, 75
Anticlinal Interior.....	10
Area of Coal Field.....	13
Armstrong Creek.....	44
Armstrong Coal Seam.....	29, 50, 53
Aughtery's Gap.....	8, 11
Baine Seam.....	39, 57, 58
Basins.....	11, 15
Bee Ridge.....	13, 38
Big Seam.....	30, 39, 71
Blackband.....	27, 35, 40, 51, 72
Blackburn Fork of Little Warrior.....	10, 11, 25, 28, 32, 37, 45, 55
Blackburn River Basin.....	11, 12, 50, 54
Blount Mountain.....	7, 9, 11, 12, 16, 28
Brasher's Mill Site.....	10, 37
Bristow's Cove.....	9, 12, 22, 33, 36, 49
Buzzard Rocks.....	21
Bynum Seam.....	28, 62, 63, 65
Cahaba Coal Field.....	8, 23, 72
Calvert Fork of Little Warrior.....	11, 12, 55, 66
Canoe Creek.....	11, 17, 20, 32, 37
Carnes' Coal Seam.....	29, 59, 60
Caskie Coal Seam.....	13, 30, 32, 33, 36
Crystallized Limestone.....	17
Clements' Coal Seam.....	29, 42
Clowdus Gap.....	11, 24, 26
Coal Bed Branch.....	10, 37
Coal Sections.....	24, 25, 27, 28, 32, 34, 36, 38, 42, 43, 45-7, 51, 52, 57, 59, 60, 64
Cock's Comb.....	13
Conglomerates, First.....	13, 14, 15, 18, 19, 21, 28, 31, 32
" Second.....	13, 14, 20-22, 31, 32, 35
" Third.....	22, 44
" Fourth.....	14, 22, 56, 63, 65

Contents, Table of.....	5
Cowden Coal Seam.....	24, 28, 69-72
Dearmon's Creek.....	10, 37, 38, 40
Declination of Measures at Locust Fork.....	34, 55, 61, 62, 67
Details.....	31
Difficulty Creek.....	10, 37
Drainage.....	11
Extent of Coal Field.....	8
Farley Seam.....	29, 48
Faults.....	14, 21, 27, 33, 68
Flexure at Warrior River.....	22, 34, 55, 61, 62, 67
Fossil Coal Plants.....	16, 29, 41, 47, 49, 72
Foster's Chapel.....	42
Gaither G. F. Coal Seam.....	29, 59, 60, 63
Garner Coal Seam.....	30, 36, 37
General Outlines.....	8
General Section.....	28-31
Geological Survey.....	8, 42, 45, 54, 69, 73
Gilland's Gap.....	21, 35
Greasy Cove.....	8, 21
Gregory's Gap.....	12, 21, 33
Guide Seam.....	49
Harris Coal Seam.....	30, 38
Haynes Coal Bed.....	49, 51
Hayse Gap.....	12, 65, 68
Holt Place.....	10, 30, 39, 70-72
Holt Seam.....	39, 70-72
Howard Coal Seam.....	13, 30, 34, 36
Hullett Seam.....	30, 36, 37
Hurricane Creek.....	37, 38
Interior Anticlinal.....	10
Introduction.....	7
Ivy Hole Seam.....	30, 44
Jackson's Seam.....	30, 43
Jourdan Seam.....	30, 44
Letter of Transmittal.....	4
Limestone.....	15, 17, 19
Line Creek.....	12, 21, 33, 35
Little Warrior River.....	11
Locust Fork Basin.....	12, 37, 45, 50
Locust Fork of Warrior River.....	9, 11, 12, 22, 28, 43, 55, 59
Lowe Seam.....	30, 36, 37
Lower Baine Seam.....	57, 63
Lower Coal Measures.....	15, 18, 19
Lower Conglomerate.....	13, 15, 18, 28

Lyttleton	21
Mace-Murphree Seam	47
Maldin's Gap	32, 85
Marble	17
Mountain Limestone	15, 17
Murphree's Valley, Rim of	7, 9, 11, 13, 21, 66
Murray Coal Seam	30, 41, 46, 47
Oil Basin probable	10
Paine Coal Seam	29, 59, 61
Peacock Coal Seam	13, 30, 31, 32
Plateau Region	7, 8, 12, 15, 18, 20, 62
Phillips' Seam	29, 56, 58
Ponch Creek	22, 56, 59
Prof. McCalley	8, 15, 18, 20
Quartzitic Rocks	23, 29, 56
Questions unsettled	67-74
Railroad Survey	33
Sally Hole Seam	29, 47
Sand Creek Seams	10, 30, 37, 39
Second Conglomerate	13
Sections of Strata	7, 15, 18, 19, 24, 26, 28-31, 63, 67
Shaly Cliff	17-18
Sheffield Gap	22
Smith Coal Seam	59, 60, 61, 62
Springville	8
St. Clair county	7, 8
Straight Mountain	7, 9, 11, 13, 14, 22, 24, 68, 71
Structure of Coal Field	8, 9
Sub-Conglomerate Measures	13, 14, 15, 16, 19
Sub-Divisions of Coal Field	12
Synclinal Fold	9, 74
Table of Contents	5
Taits' Gap	11, 12, 55
T. A. & C. R. R.	33
T. & C. R. R.	21
Transmittal, Letter of	4
Trough Shaped Field	10
Tumbling Gap	21, 35
Unsettled Questions	67-74
Vertical Measures	13, 14, 21, 22, 24, 25, 26
Waide's Gap	24, 69
Waide, G. B.	33, 34
Waide Seam	25, 30, 40, 68
Walker's Gap	21, 28, 31
Walnut Grove	12, 21, 49

Warrior River.....	9, 11, 22
Washington Coal Bed.....	30, 44
Watersheds.....	7, 11, 55
Woodward Coal Seam.....	29, 53, 54

ERRATA.

On page 21, last line, for "*Bucks' Pocket*" read "*The Dungeon*."

Page 23, eighth line from bottom, for Southeast read Southwest.



R.V.E.

AND

CONGLOMERATE.

HOWARD SEAM. 5'-6"

PRISMATIC SHALE.

CORKIE SEAM. 5'-8"

REDDISH COLORED SOFT

SANDSTONE & SHALE.

PEACOCK SEAM. 1'-7"

BUILDING STONE.

THIN SEAM.

TOP OF LOWER CONGLOMERATE.

CONGLOMERATE.

ETNA SEAM. 1'-0"

FLAGGY SANDSTONE.

SHALY CLIFF.

SHALE.

SIGNS OF COAL - THIN.

LIME MARBLE GROUP

SLATE

COAL SEAM 1'-0"

SOFT BROWN SANDSTONE

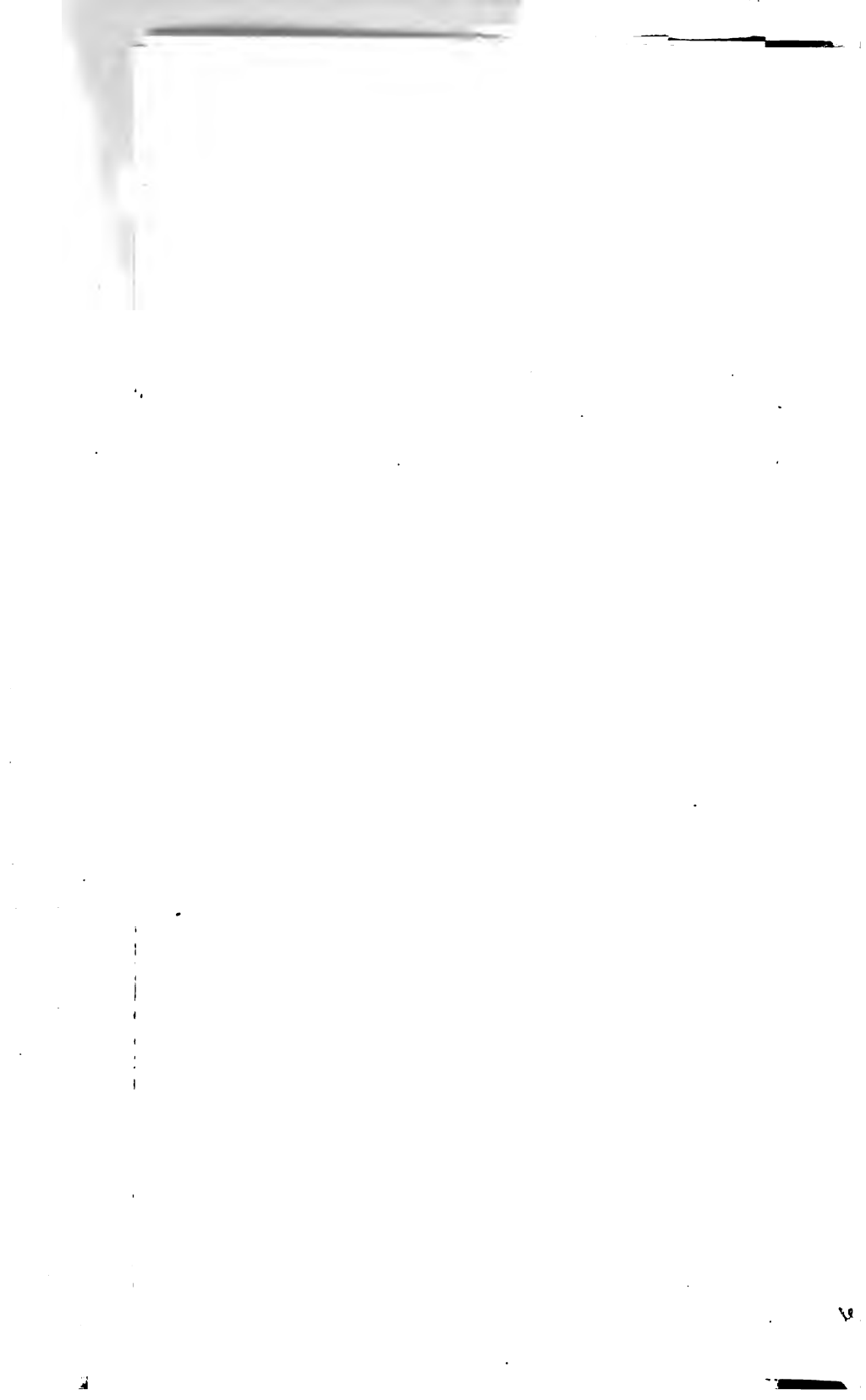
FLAGGY SANDSTONE.

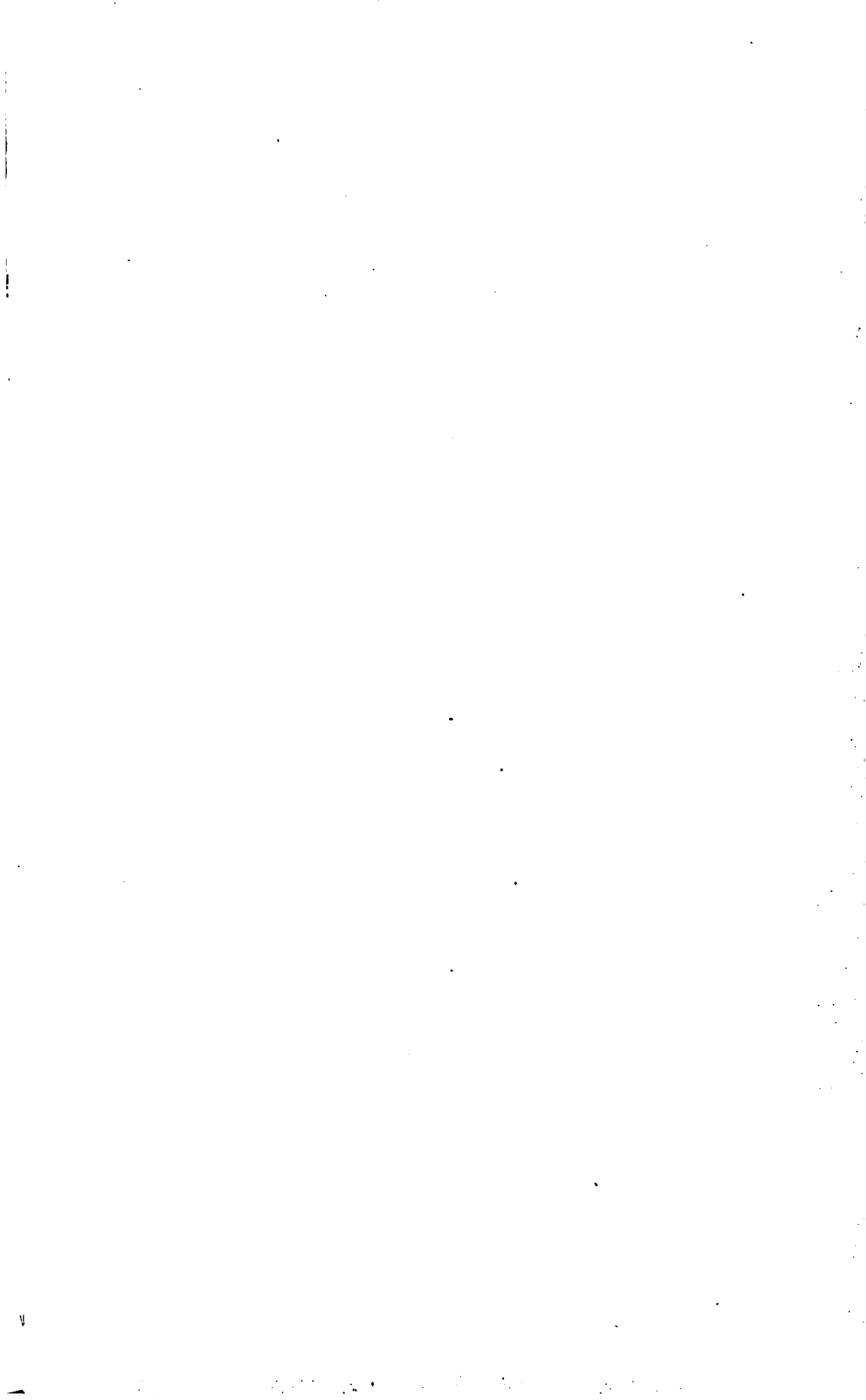
COAL SEEN IN CANAL CREEK P.

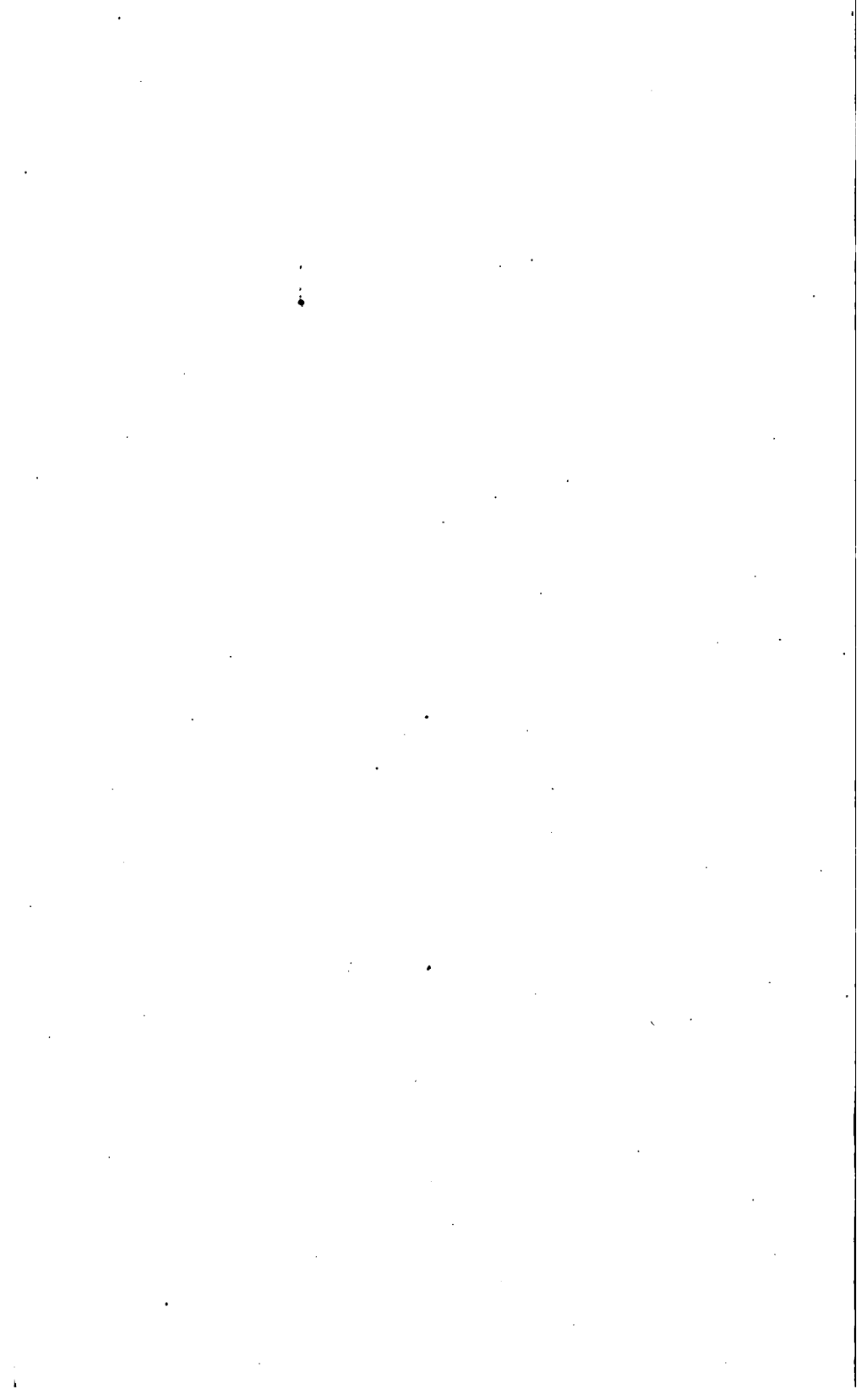
BLUE FLAGGY SANDSTONE.

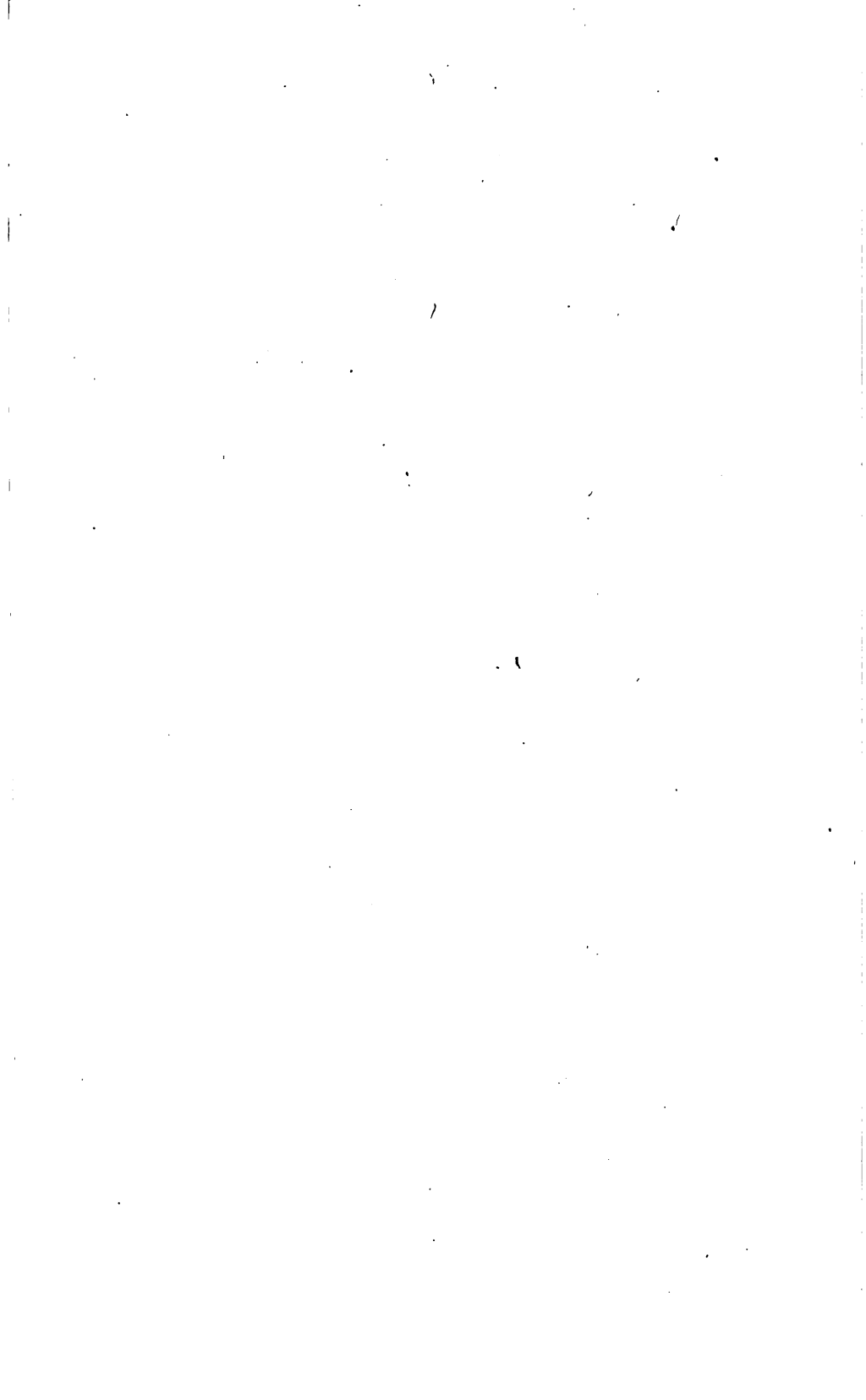
CALCAREOUS SHALE.

BASE OF COAL SEAM.









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